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ABSTRACT

Background papers and recommendations from the American Association of Community Colleges' (AACC's) 1992 roundtable on issues facing minority students in mathematics, science, and engineering (MSE) education are presented. The first paper, "Community College Networks," by Wm. Carroll Marsalis and Glenna A. Mosby, describes the Tennessee Valley Authority Community College Network initiative, a cooperative effort involving 40 public two-year institutions in improving workforce skills through advanced technical skills development, instructor training and retraining, tech prep, university joint venture partnerships, continuing education, and mentoring. "Enhancing Success of Minority Students in Hawaii," by David Kawate, describes a program at Kaua'i Community College to assist Filipino, Hawaiian, and part-Hawaiian students in their studies, sensitize faculty to their needs, and recruit minority faculty. "A Native American Model," by Daniel Wildcat and Edward Necefer, discusses Haskell Indian Junior College's (Kansas) development of a mathematics program which incorporates Native American instructional materials, promotes sensitivity to the students' worldview, and demands high academic standards. "Motivating Minorities To Pursue Math, Science, and Engineering Careers," by Karla Alvarez, explores reasons that the number of minorities pursuing MSE careers are decreasing and recommends ways of altering the educational approaches in these fields to reverse the trend. "The Tuskegee University Model," by B. D. Mayberry, discusses how Tuskegee University, with aid from national forestry programs, developed a successful pre-forestry program. "Coalition Building," by Lourdes Tinajero, offers recommendations on developing coalitions between academia, business, and foundations that target minorities for MSE careers. Finally, recommendations are presented in the areas of curriculum development, coalition building, faculty development, the learning environment, and funding. An executive summary is included. (ECC)

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LESSONS FOR THE FUTURE

MINORITIES IN MATH, SCIENCE, AND ENGINEERING AT COMMUNITY COLLEGES

JC 930 492

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Lessons for the Future

Minorities in Math, Science, and Engineering at Community Colleges

Enid B. Jones, Editor

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Part I

PREFACE

DAVID R. PIERCE

WHEN THE EXXON EDUCATION FOUNDATION DECIDED TO sponsor a roundtable on minorities studying in the areas of mathematics, science, and engineering at community colleges, we at AACC were excited at the prospect of being part of the process. The Tennessee Valley Authority accepted an invitation to join the effort, and this collaboration resulted in a very interesting and informative session on ways to enhance the success of minority students in the areas of mathematics, science, and engineering.

The six individuals selected to present background papers at the roundtable provided a way to integrate ideas and perspectives from industry, community colleges, and historically Black colleges. The recommendations from the roundtable are summarized in this publication, but the excitement generated by the discussion cannot be included here. The fact that the collection of papers did not include one on an engineering program other than civil engineering is a reflection of the lack of work done in expanding these programs in the community college.

AACC will continue to promote the expansion of programs and policies that will benefit minority students studying mathematics, science, and engineering. This commitment is embraced in AACC's "Minority Students in Community Colleges" policy statement, adopted by the AACC Board of Directors in 1988, in which it is stated:

> Community, technical, and junior colleges embody the American ideal of democracy; they were the first to proclaim higher education

David R. Pierce is president and chief executive officer of the American Association of Community Colleges.

an enfranchising vehicle—an opportunity accorded to all Americans. Community colleges, as principal providers of higher education to the traditionally underserved segments of the population, have a special responsibility to serve the needs of the minority student.

Part II

EXECUTIVE SUMMARY

ROUNDTABLE ON MINORITIES IN MATHEMATICS, SCIENCE, AND ENGINEERING AT COMMUNITY COLLEGES

BY
ENID B. JONES

On August 13–14, 1992, a roundtable was convened by AACC in Washington, D.C. to discuss the issues facing minority students in mathematics, science, and engineering (MSE) education. The roundtable was chaired by Enid B. Jones. A variety of experiences and suggestions were offered through the presentation of papers and the roundtable participants' responses to them. Six papers were presented at the roundtable, the full text of which follows this executive summary. The papers identify current problems in minority mathematics, science, and engineering education, provide non-traditional perspectives and solutions to the problems, and offer suggested courses of action.

The following is a summary of the ideas presented in each of the papers. The roundtable's recommendations appear after the papers.

Community College Networks

Presenters: Wm. Carroll Marsalis and Glenna A. Mosby
Tennessee Valley Authority

While half of all projected labor growth will be among African Americans and Hispanics, skill deficits are more prevalent among these minority populations. Given that community colleges enroll a large percentage of minorities, these colleges are in a position to address the problem of producing a skilled minority work force.

Enid B. Jones is executive director of the AACC Commission to Improve Minority Education.

The Tennessee Valley Authority Community College Network Initiative was established in 1991 to assist in developing a network of institutions that can share services and expertise. The network is currently composed of 40 public two-year institutions working toward the goal of improving the skills of the work force. Program development targets the following areas: advanced technical skills, instructor training/retraining, tech prep, university joint venture partnerships, and continuing education. An essential part of the overall program is the recruitment and retention of women and minorities.

The Tennessee Valley Authority has found that successful programs exhibit five essential characteristics: the programs are community based, are cost-effective, provide a caring environment, employ competent faculty, and offer a comprehensive community college program. The Tennessee Valley Authority Community College Network programs possess all of these qualities. Participating community colleges are committed to and develop partnerships within their communities. Corporations aid cost-effectiveness by providing financial assistance through scholarships. Mentoring programs foster a caring environment. Properly trained faculty are able to promote success among minority students, and the value of faculty diversification as a retention tool is recognized. Tech prep programs with high schools offer a comprehensive program that is able to aid recruitment of minority students into mathematics, science, and engineering fields.

The Tennessee Valley Authority, through the Community College Network, has successfully paired the resources of academia and industry. The result is a successful program that meets both the educational needs of minority students and the business community's need for a trained work force.

Enhancing Success of Minority Students in Hawaii

Presenter: David Kawate
Kaua'i Community College, Hawaii

Filipino, Hawaiian, and part-Hawaiian students are the most underrepresented ethnic minorities at Kaua'i Community College. The college has developed programs aimed at sensitizing the faculty to the needs of these minority populations through professional development activities and active recruitment of minority faculty members. Kaua'i Community College has been particularly successful with three programs: the Hawaiian Studies Initiative, the Nursing Program

Minority Enhancement Effort, and a program for facilitating transfer to four-year institutions.

The Hawaiian Studies Initiative helps minority students succeed in college through recruitment and retention efforts, academic advising, and peer counseling. The initiative also includes a Summer Bridge Program that assists underachieving students in making the transition to college. This program is responsible for a dramatic increase in enrollment of native Hawaiian students.

The Nursing Program Minority Enhancement Effort seeks to increase admission and retention of students at academic, social, and psychological risk. To this end, pre-nursing students who do not meet nursing requirements are given academic support upon admission into the nursing program through placement into academic enhancement groups. In addition, a tech prep relationship was established with the high schools, along with an upward linkage with the University of Hawaii.

Kaua'i Community College has also developed a program to assist students transferring to four-year institutions. The four-year transfer program includes coordinated testing, workshops, assistance in transferring credit earned, and professional support.

These programs have enabled Kaua'i Community College to assist students from high school to graduate school. The programs involve many members of the faculty and staff, enhance the success of ethnic minority students in all fields, and provide opportunities for faculty and staff to work collaboratively with the community and other educational institutions. The result has been the creation of a supportive learning environment for minority students.

A Native American Model

Presenters: Daniel Wildcat and Edward Necefer
Haskell Indian Junior College, Kansas

Haskell Indian Junior College found that the problem in preparing minority students for mathematics was the failure of the college to provide a program that applied creative and culturally sensitive teaching methods. Specifically, the college noted that most instructors lacked an understanding of Native American cultures, the contributions of Native Americans to world development were not discussed in the classroom, instruction failed to address the historical significance of math to Native American cultures, and there was an absence of Native American role models in mathematics. To correct this

situation, a math program was established to promote student success that maintained high academic standards while at the same time promoted sensitivity to the humanistic and holistic worldview of Native Americans.

Under the program, instructors incorporated Native American materials into courses to create a more effective learning environment. The program also assessed the learning styles of the students, and teaching methods were adapted accordingly. Required instructional contact hours were increased, and departmental final examinations were developed for pre-college courses in order to better prepare students for college-level classes. Instruction was also enhanced with a tutorial program that included peer tutoring.

Haskell Indian Junior College found that a program that incorporated the needs and the culture of the students into the curriculum resulted in a significantly higher success rate in mathematics courses while preserving academic integrity.

Motivating Minorities to Pursue Mathematics, Science, and Engineering Careers

Presenter: Karla Alvarez
Camp, Dresser & McKee

The decrease of minorities pursuing careers in mathematics, science, and engineering has negative consequences for minority populations and our nation's standing in a global economy. Minority students' lack of interest in these fields may be linked to specific problems. First, students lack exposure to role models in technology fields. Second, traditional teaching methods have relied on repetition and memorization with very little emphasis on critical thinking. Finally, the creation of advanced placement programs effectively segregates students and creates elitist educational programs that limit the available opportunities.

The problems identified above require a re-examination of many aspects of our educational system. Changes would include adopting teaching methods adapted to students' learning styles, tutoring, emphasizing problem-solving skills, publicizing role models, and creating partnership programs. Restructuring the educational approach to mathematics, science, and engineering in this way would benefit individual students, the technology professions, and our nation's ability to compete internationally.

The Tuskegee University Model

Presenter: B.D. Mayberry
Tuskegee University, Alabama

In order to understand the success of the pre-forestry program at Tuskegee University, it is important to note the unique role that historically Black colleges and universities have played in the education of minorities. These institutions developed as a response to the changing educational, economic, and political climate of the nation over the last two centuries. Historically Black institutions are unique in that they were originally restricted to serving the educational needs of minorities. The result was an educational atmosphere that included allegiance, support, compassion, and devotion.

In 1968, it was generally believed that minorities were not interested in pursuing careers in forestry. Tuskegee University set out to challenge this assumption. Initially, the program faced problems in recruiting and retaining students when no role models could be provided, availability of scholarships was very limited, and recruiters and counselors were still bound to stereotypes of minority students that were not associated with leadership responsibilities.

These barriers were overcome with the assistance of many forestry programs across the nation that provided academic training and financial support. Major sources of support included the U.S. Forest Service, cooperating universities, the Weyerhaeuser Corporation, and the Forest Resource Council.

Tuskegee University has successfully met the challenge and proven that minorities are interested in careers in forestry. Since the program's inception most graduates immediately secured professional forestry jobs with public or private agencies. Many of these students later earned graduate degrees, and others received significant promotions within the forestry profession.

Coalition Building

Presenter: Lourdes Tinajero,
National Science Foundation

Community colleges enroll approximately half of all Hispanic, Native American, and African American students. Accordingly, community colleges have a responsibility to develop and provide effective mathematics, science, and engineering curricula for minority students. In meeting this challenge, community colleges must be more aggres-

sive in addressing the needs of minority students by developing an interest in mathematics, science, and engineering in K–12 students, identifying high school students with the potential to earn college degrees, and assisting students in transferring to four-year programs.

The development of coalitions that include all levels of academia, industry, business, government agencies, private foundations, and professional and student organizations would effectively address the problem of producing qualified minority professionals in mathematics, science, and engineering fields. A significant benefit derived from networks developed through these coalitions is the consolidation of resources and skills.

Community colleges must be active in the development and leadership of coalitions that target minority students. Coalition development can be accomplished with careful planning and an examination of other coalition programs. Several model coalitions are summarized in this paper.

Coalitions must confront the essential problems facing minority MSE education through the establishment of a national database for tracking transfer students, development of transfer agreements between community colleges and four-year institutions, programs aimed at promoting interest in MSE education, and programs that encourage the completion of undergraduate and graduate degrees. If these issues are effectively addressed, the resulting coalitions should produce more prepared and productive mathematics, science, and engineering professionals.

Karla Alvarez and Daniel Wildcat presented their background papers at the AACC Roundtable on Minorities in Math, Science, and Engineering.

Part III

BACKGROUND PAPERS

- Community College Networks
  by Wm. Carroll Marsalis and Glenna A. Mosby
- Enhancing Success of Minority Students in Hawaii
  by David Kawate
- A Native American Model
  by Daniel Wildcat and Edward Necefer
- Motivating Minorities to Pursue Math, Science, and Engineering Careers
  by Karla Alvarez
- The Tuskegee University Model
  by B.D. Mayberry
- Coalition Building
  by Lourdes Tinajero

WM. CARROLL MARSALIS AND GLENNA A. MOSBY

Community College Networks

The nation that leads the world in the next century will be the one that has the highest literacy rate, the best schools, the best work force, and a strong commitment to applied research and development. In this country, we cannot be competitive unless we have a productive, skilled work force. The recognition of that fact is the common bond that brings us together (business and education) to support progressive economic development goals and objectives.

—William F. Willis, Senior Executive Officer and President, Board Advisory Group, Tennessee Valley Authority

IN ADDITION TO ITS ELECTRIC UTILITY AND NATIONAL RESEARCH capabilities, the Tennessee Valley Authority (TVA) has broad economic and human resource development responsibilities in an area composed of all or parts of seven states.

Faced with the task of improving human capital in a region that covers 91,000 square miles and 8.5 million people, TVA turned in 1991 to the region's community colleges. The TVA Community College Network (CCN) initiative was born. The network is composed of 40 public two-year institutions in the valley, along with several other schools that serve one or more of TVA's 201 counties. Network institutions are grouped into 10 clusters, based on geography but without regard to state lines. Programs are delivered through these clusters as well as through individual institutions.

A basic objective of the CCN is to assist valley postsecondary boards of governance, as well as individual community colleges and technical schools, in developing an interstate network of institutions that can share services and expertise in equipment, facilities, staff improvement, and curricula. The network heavily uses demonstration sites that were established by TVA and others in the past.

CCN's primary goal is to improve the skills of the work force. Strategies and programs are designed to upgrade faculty, develop and

Wm. Carroll Marsalis is program manager and Glenna A. Mosby is project manager, Community College Initiative, Tennessee Valley Authority.

improve curricula, link secondary school occupational offerings with community college courses, and coordinate advanced technology information and materials for member institutions.

The initiative has identified five distinct focus areas:

- Advanced technical skills, which address the improvement of instruction in technical programs through the sharing of state-of-the-art curricula and materials
- Instructor training and retraining, which is designed to upgrade technical faculty at valley community colleges and technical schools
- Tech prep (2 + 2), which is high school- and community college-based, with a provision for short-term adult training and retraining
- University joint venture partnerships, which extend the tech prep model into four-year institutions and create new partnerships to address applied research and instructional programs in management science and engineering technology
- Continuing education, which features special non-credit workshops and seminars specifically designed to meet current work force deficiencies

Because a growing number of minorities and women attend two-year colleges in the valley, the recruitment and retention of diverse populations is an essential part of the overall program.

The framers of CCN agree with Naisbitt (1991) that demographics and shifting workplace attitudes are dramatically reshaping the American work force. Yet recent studies show that minority groups continue to lag behind their counterparts in measures of income, earnings, employment status, and education. This is especially true in matters related to science and technology.

Participating schools are actively seeking ways to open doors of opportunity for women and minorities in science and engineering education. This push is critical because of changing technology, fierce international competition, and the movement toward a business-quality-based culture in the United States.

The U.S. Department of Labor considers high-skill, high-wage employment an indispensable condition of a high-performance economy. *U.S. News & World Report* (Whitman, et al, 1989) contends that national economic security may depend on a diverse group of workers who are less schooled as much as it will on the software

programmers and the rocket scientists. While student diversity is not a new phenomenon for community colleges, the dimensions of the challenges posed by the diversity are exacerbated by the increasing demands of a complex and rapidly changing technology. Community colleges are charged with preparing students from various ethnic, cultural, and socioeconomic backgrounds, students with a host of divergent needs and academic skills, to meet the challenges of an emerging global economy (McCabe, 1988).

A staggering percentage of potential workers lack the skills to perform the jobs of the twenty-first century. Skill deficits are far more graphic among African Americans and Hispanics who inhabit the inner cities. Between now and the year 2000, 57 percent of all labor force growth will be in these two groups, or in other minorities who typically receive less schooling than Whites (Whitman, et al, 1989) and are considered "high risk" (Jones and Watson, 1990). The skill hurdle is quite pronounced in the service sector, where many of the nation's jobs will occur for the next century. There is a growing realization that occupations with the largest number of new jobs for the next decade will require people who can read, reason, and learn new tasks on their own (Whitman, et al, 1989).

This realization operates in tandem with a sense of urgency to implement an agenda for national well-being, and a commitment to transform the face of education. Concern about the efficacy of American education from many fronts fed the creation of the Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). The 1992 SCANS Report for America 2000 (*Learning a Living*) advocates learning processes that take into account realistic contexts where foundational competency is required. Its message to a tripartite audience of students, teachers, and employers stresses the interdependence of roles each must play in order to define and to achieve the skill base that facilitates the high-performance workplace. This message is voiced by many federal and corporate entities, such as TVA, that have a vested interest in economic viability and a diverse work force.

Integral to education reform is program restructuring so that quantitative disciplines (i.e., math, science, and engineering) will cultivate the interests of all students rather than serve as a screening device. Of necessity, these fields of study must become more relevant to student interests and needs. The SCANS model—which includes articulation, applied academics, school-to-work programs, and industry/education partnerships, among other validated methods—is a mean-

ingful framework for pursuing more opportunities to foster strategies that respond to the many challenges confronting educators and employers.

According to Massey (1992):

> One way to imagine this connection between the challenges and the opportunities is to think of them as forming the two sides of an equation where the opportunities are a function of the challenges. The crucial parameters that will determine the overall magnitude of the equation are related to the strength of the nation's knowledge base—the research enterprise, the human resource base, the work force skills, as well as the necessary infrastructure to connect people and ideas (p. 157).

Both sides of the challenge-opportunity equation are greater for such groups as women, African Americans, Hispanics, Native Americans, Alaska and Pacific Island natives, and persons with disabilities, all of whom have been historically underrepresented in the technologies (Massey, 1992). There is evidence that the early interest of African American students in math, science, and engineering seems to be lower on the average than that of the general student population. The premium placed on these content areas is magnified by the urgent need to develop new technologies for industrial application and consumer consumption. Many of the manual jobs that continue to be replaced by these technologies are largely held by African Americans (Miller, 1991). Consequently, their preparation for, and transition into, high-tech jobs requires the removal of barriers that encumber their access to technological education and subsequent employment.

So, while there are benchmark initiatives such as SCANS to provide an infrastructure and facilitate the connections between challenges and opportunities, the demanding task of producing a large minority work force has not been addressed. Meaningful dialogue between partners in education and training must take place to advance the attainment of the higher skill levels that correlate with high-wage jobs and a high-performance economy. In recent years, collaboration among colleges, community-based organizations, and businesses has become quite popular in attracting and educating minorities (Astone and Nuñez-Wormack, 1990). State and federal governments promote partnerships between business and higher education to enhance economic competitiveness and to encourage participation in disciplines that are essential to future economic vitality (Fairweather, 1988). As

a federal and corporate utility, TVA participates in and applauds these kinds of efforts.

Two-year colleges are invaluable in the partnership enterprise. In terms of proportional representation, minorities are heavily concentrated in two-year schools, with the majority of Hispanic and Native American students being enrolled in these types of institutions (Astone and Nuñez-Wormack, 1990). Parnell (1985) has succinctly pointed out the responsibility of community colleges in leading the vanguard in developing and sustaining quality educational programs that serve the needs of a forgotten majority of "average" students who will not go on to earn baccalaureate degrees. The future members of the forgotten half may be even less prepared for the work world than their counterparts of today because the 1990s mark the end of the era of the White male worker, who has traditionally been considered the best employee (Whitman, et al, 1989). The implications of increasing stratification along economic, educational, employment, and ethnic lines include a devaluing of human resources, damaged self-esteem, and a widening gap between the haves and the have-nots (Parnell, 1985). Through proactive attention to these kinds of issues, two-year institutions can play an increasingly pivotal role in meeting the national goal of world-class educational and economic status.

Parnell (1985) cites five characteristics of the "opportunity with excellence" philosophy operating at community colleges that strive for excellence. Joint ventures that can increase the pool of minority students in math, science, and engineering emerge from these philosophical underpinnings. These elements can be referred to as the five C's:

- Community-based
- Cost-effective
- Caring environment
- Competent faculty
- Comprehensive community college program

Community-Based Education: Organizing for Outreach

Community colleges have become partners with businesses and community-based organizations to develop strategies for success among high-risk students (Jones and Watson, 1990). The first step

in this strategy, recruitment of minority students, requires maintaining a presence in the community. Teacher liaisons can play a potent role in influencing students who might not have considered college. Valencia Community College, Florida, for example, works with local high school teachers to identify high-risk students and facilitate their enrollment in college (Astone and Nuñez-Wormack, 1990). Recruiters can attend civic or cultural activities and interact with recognized community leaders. An understanding of college life and expectations allows parents to support their children's college entrance and timely completion (Astone and Nuñez-Wormack, 1990).

Once minority students have been recruited into the two-year college system, the business community can take definitive steps to reduce the risk of attrition. Many corporations are creating business and education councils, management personnel "loans," and adopt-a-school programs (Jones and Watson, 1990). An enduring signal of these corporate commitments is evidenced in the level of assistance to the communities and to two-year colleges in particular in improving minority opportunities.

Cost-Effective Education: Corporate Assistance

Although community colleges make every effort to stay within the financial reach of their students by maintaining low costs and tuition (Parnell, 1985), financial assistance for college is still a major part of the postsecondary education picture. Financial assistance is most frequently based on academic achievement, leaving less academically prepared students with fewer options. Minority families already facing financial uncertainty are often unable to assume the responsibility of educational loans (Astone and Nuñez-Wormack, 1990). Contrary to popular belief, there is not enough financial aid available for minority students who want to pursue careers related to math, science, or engineering (Miller, 1991). This is best understood when considering that African Americans and Native Americans have the lowest median household incomes and the highest unemployment rates. Hispanics remain at the bottom in education.

Corporate contributions of scholarships can increase access for specific groups that otherwise could not afford a college education (Fairweather, 1988). Corporations can assist by increasing the number of scholarships they provide and revamping the conditions under which they are awarded. Alternatively, or in concert, they can make

donations to operating funds, assist in upgrading facilities, lend equipment and offer discounts for equipment purchase, hire students for co-op or summer work, or supplement faculty salaries, thereby allowing more flexibility in institutional budgets to subsidize students' education (Fairweather, 1988).

Caring Environment: Mentoring

Mentoring is a career development tool that can have a positive influence on the person-environment fit for the minority student. The climate of the campus, and the degree to which it is welcoming or hostile, affects minority students' coping ability and their determination and desire to remain on the campus, and perhaps even in academia (Astone and Nuñez-Wormack, 1990; Smith, 1989). Although Astone and Nuñez-Wormack (1990) use the terms "role model" and "mentor" interchangeably, it is important to note an operational distinction, that the identification of role models cannot substitute for structured mentoring. Role models are typically passive, so they may not be aware of any role they have in contributing to the growth and professional development of a student. In contrast, mentors directly and intentionally nurture students by displaying a personal interest in their lives and their degree completion (Rogers, 1986). Failure to grasp the benefits of the degree can occur if there are not individuals in positions of authority with whom the student can identify and perceive as able to identify with the student's personal situation (Astone and Nuñez-Wormack, 1990). Because the portrayal of scientists and technologists is not always easy to relate to, psychological and cultural support can be gained by engaging minority professionals in mentoring (Miller, 1991).

Redmond's (1990) examination of the expanded role of mentoring found that informal formats rarely deal with some of the more practical or philosophical issues related to the dynamics of cultural pluralism or diversity. It could be said that same-race developmental relationships generally provide more psychological support; however, the dearth of some ethnic minorities in technology may preclude this. Resulting cross-race mentor-mentee relationships are enriched by cultural awareness (Redmond, 1990).

Mentoring must be a planned experience rather than happenstance. By focusing on day-to-day issues and graduation benefits, mentoring has powerful retention outcomes. Proteges become more intimately

acquainted with their chosen fields when they can see applications of what is being taught in the classroom. Thus, they are likely to be better trained and more highly motivated to enter the world of work (Rice, 1991). Rice highlights the multiple and reciprocal effects of mentoring when it is properly structured. In addition to involving faculty and staff, mentoring programs can be assisted by industry personnel. This type of interaction signals the commitment of these prospective employers to the importance of vocational-technical students and to their mutual employment needs. As an additional benefit, the cooperation required between industry and education to conceptualize and to activate such a program creates a forum for substantive exchanges that could result in improved technologies.

Once the goals for a mentoring program are established, the scope of the program should be determined. Rice (1991) suggests starting small and building slowly in order to avoid budget problems or lack of continuity. The inclusion of factors that make a program successful requires strategic planning and thought of outcome goals and how best to accomplish them. Considerations from Rice's (1991) design are the choice and training of mentors; program evaluation component; mentoring plan/timetable; future activities to evolve from mentoring; and mentor/protege match (gender, ethnicity, background).

Competent Faculty: Instructional Strategy

Competent faculty are at the center of the caring environment (Parnell, 1985). Their competence extends far beyond their credentials and addresses their ability to empower students to learn. Negative attitudes and inappropriate instructional techniques may promote risk and undermine retention. Faculty must be transformed into trained facilitators of the learning process (Jones and Watson, 1990) who can foster success strategies and value diversity (Smith, 1989).

A diverse faculty is a retention tool in that it creates a more comfortable and caring environment that mitigates the sense of loneliness and isolation minority students experience (Smith, 1989). Whether or not minority students consciously select a campus because of the presence of professional people of color is an unresolved issue in the literature. However, access to faculty who can understand and communicate to others the values of the student's culture can have a motivating, positive effect (Astone and Nuñez-Wormack, 1990).

Faculty competence, then, can also be examined against a backdrop of response to students who are culturally different. A number of studies have documented the operation of a race-based ontology in the classroom. An outgrowth of this ontology is differential classification of students, disproportionate attrition rates, and the projection of negative attitudes about life chances and prospects for academic success (Jones and Watson, 1990). Faculty can coordinate with learning skills instructors to provide developmental assistance, perhaps in the form of adjunct courses offered for such high-risk subjects as math and science (Tomilson, 1989) to enhance retention of high-risk students. Failure to meet the great range of individual differences is a barrier to excellence that can be combatted by cultivating educational diversity to match the diversity of the student body and levels of preparedness (Parnell, 1985).

The incorporation of "developmental education" strategies holds great promise for assisting students in obtaining required proficiency levels in a non-threatening environment. Developmental education takes into account the expanse of instructional services and programs for high-risk students that are unified by basic educational assumptions about learning styles, and the ability of those with varied cultural or environmental backgrounds or physical or economic handicaps to learn, given the appropriate conditions and strategies (Tomilson, 1989).

Research has documented that an ethnocentric college environment and a Eurocentric faculty worldview can directly affect high-risk students' self-esteem and concomitant performance. These same students can become "push-outs" (Jones and Watson, 1990). The literature is clear about the importance of the faculty role in creating an institutional environment that is affirming rather than alienating (Smith, 1989). Faculty must adopt a learning-in-context perspective to heighten their competence. Applied academics, exemplified in the 2 + 2 tech prep/associate degree program, is a teaching-in-context innovation that integrates academic and work force skills (Pedrotti and Parks, 1991; U.S. Department of Labor, 1992). As a parallel, deliberate steps must be taken to ensure cultural contextual learning, as in the case of Borough of Manhattan Community College's bilingual program to reinforce the academic skills of its Hispanic students (Jones and Watson, 1990).

Comprehensive Community College Program: Tech Prep and Articulation

Tech prep, as mentioned earlier, is a new educational innovation that offers promise of recruiting students into math, science, and engineering fields and retaining them. In its purest form, tech prep is an effort targeted toward the 50 to 60 percent of high school students who have been classified by Parnell and others as the "neglected majority," or "forgotten half" who are neither college- nor technical school-bound but are in a general program of study leading to oblivion (Parnell, 1985). Generally known as a 2 + 2 program, tech prep prepares individuals for skilled occupations or for further educational endeavors at four-year institutions. Basically tech prep is a four-year sequence of study beginning in the junior year of high school and ending with an associate degree from a two-year institution. The program requires intensive counseling and curriculum articulation. In numerous pilot demonstrations, tech prep, because of its practical but demanding applications, has proven effective in raising a high level of student interest in science and technology subjects. Tech prep has become a cornerstone of TVA's Community College Network program.

Dan Hull, CEO and president of the Center for Occupational Research and Development and one of the nation's leading tech prep proponents, explains tech prep in the following manner:

> The tech prep curriculum is a careful balance of head skills and hand skills that runs parallel to the college/baccalaureate degree program in high school. It presents a rigorous body of knowledge in a hands-on setting and relates it to personal or social situations relevant to the workplace. Applied academics in mathematics, science, and communications form the strong academic foundation for the tech prep programs, which enables students to understand complex technologies and new skill requirements in work environments. The program tolerates no "watered down" courses, but maintains the same academic integrity as the college prep curriculum (Hull, 1992).

Because tech prep was included in the Carl D. Perkins Vocational and Applied Education Act Amendments of 1990, there can be no question that minorities will have an important resource to draw on for entrance into the world of science and technology. Perkins-

supported tech prep programs contain the following requirements, with the implications self-evident:

- An articulation agreement between consortium participants
- A 2 + 2 design with a common core of proficiency in math, science, communications, and technologies
- A specifically developed tech prep curriculum appropriate to the needs of consortium participants
- Joint in-service training of instructors to effectively implement the tech prep curriculum
- Training programs for counselors to recruit students, ensure program completion, and ensure subsequent appropriate employment
- Equal access of special populations to the full range of tech prep programs
- Preparatory services such as recruitment, career and personal counseling, and occupations assessment

The law encourages that priority consideration be given to tech prep programs that:

- Offer effective employment placement
- Transfer to four-year baccalaureate programs
- Are developed in consultation with business, industry, and labor
- Address dropout prevention and re-entry and the needs of special populations

The 2 + 2 tech prep program discussed is one example, but there are broader applications. The need for continuity from one level of education to the other is at the heart of articulation (Hull, 1991).

Articulation can best be thought of as "a process for linking two or more educational systems within a community to help students make a smooth transition from one level to another without experiencing delays, duplication of courses, or loss of credit" (Hull, 1991, p. 42). As a process, articulation has been inculcated into the *raison d'etre* of community colleges. In states where community colleges assume a significant role in the education of minority students, articulation between two- and four-year institutions must be strengthened through student progress reports, early intervention, and coordinated student services (Smith, 1989). Many minority students are not placed in academic transfer programs when they enroll in two-year institutions. Conditions related to financial disadvantagement may motivate

them to choose programs leading to more immediate job opportunities (Astone and Nuñez-Wormack, 1990). However, as an **attitude** and a **goal** of articulation (Hull, 1991), educators should reassess minority student potential and focus on vertical articulation when deemed appropriate. The shortage of baccalaureate-degreed minority scientists (Massey, 1992; Miller, 1991) practically makes this an imperative.

The challenges to the transfer of minority students are couched in matters of curriculum, state and local bureaucracies, and financial constraints. State and national programs, such as the Exploratory Transfer Institute (ETI), a collaboration between the University of Arizona and Pima Community College, address these challenges. ETI's mission is to encourage students of color who are not considering transfer to attend summer institutes at the university, exposing them to a world they might otherwise not have considered. Another project, initiated by the United Negro College Fund, involves 16 universities and 10 community colleges in the South working together to increase the number of African American students, particularly men, who receive baccalaureate degrees (Astone and Nuñez-Wormack, 1990). The community college can provide the additional learning support to enable students to succeed in baccalaureate programs (Parnell, 1985).

A proactive transfer program can identify at the early stage of their community college career minority students who are transfer prospects. Acceptance into this type of program guarantees simultaneous acceptance into the four-year liaison institution. Such is the case with Glassboro State College, New Jersey, and its feeder community colleges, and with LaGuardia Community College and Vassar College, New York (Astone and Nuñez-Wormack, 1990).

Workforce 2000

Community colleges play a major role in preparing the labor force for the coming decades. Their formats for instruction, along with their attention to psycho-social environmental issues, can play a major role in recruiting and retaining minority students in math, science, and engineering. Further, these institutions can help to improve professional job opportunities for a diverse population of students through their contact with the business sector, as demonstrated through initiatives such as TVA's Community College Network. CCN

is a powerful example of how partnerships can be formed to help resolve the work force needs of the nation, and provide support for participation by minorities in the newly developing global economy.

The recommendations integrated into the perspective outlined above are those that represent common goals for education and industry. Their inclusion is designed to present a look into the realm of partnership benefits and to provide insight into consideration of those aspects of partnering that lead to success. Although the kind of forum TVA has established through CCN may not be an available option for many institutions, its basic premise is that industry-education cooperation yields high-profile results for economic growth.

The relationships that are forged between community colleges and employment sectors are viable, tenable, and necessary. They often require intermediary partnerships with those who are a part of the educational process in more subtle ways. Perhaps the most comprehensive view of the coming together of the various roles is through an illustration the National Urban League prepared for the SCANS Commission (U.S. Department of Labor, 1992). It provides a cogent depiction of cooperation among community, schools, employers, governmental entities, and community-based organizations (e.g., the Urban League) toward facilitating the actualization of high-performance learners and workers. It is this picture of interaction that will move all students, and certainly minority students, into the mainstream of Workforce 2000.

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TVA's Wm. Carroll Marsalis, center, and Glenna Mosby chat with AACC President David Pierce during the two-day roundtable meeting.

DAVID KAWATE

Enhancing Success of Minority Students in Hawaii

KAUA'I COMMUNITY COLLEGE (KCC) IS A SMALL RURAL COMMUNITY college with an enrollment of 1,500 students. It is the only postsecondary educational institution on the island of Kaua'i, and one of seven community colleges in the University of Hawai'i System of Higher Education. Also included in the system are the University of Hawai'i at Manoa, a baccalaureate and research campus, and two baccalaureate institutions, the University of Hawai'i at Hilo and the University of Hawai'i-West O'ahu. KCC represents the whole University of Hawai'i system on Kaua'i as an educational center and strives to meet the postsecondary educational needs of the entire Kaua'i community.

The student population at KCC does not have an ethnic majority. In fact, the college's fall 1991 student body was composed of 14 percent Japanese, 28 percent Filipino, 14 percent Hawaiian and part-Hawaiian, 26 percent Caucasian, and 18 percent other and mixed ethnicities. The major groups of underrepresented ethnic minorities (ethnic minorities underrepresented in postsecondary education and positions of influence) are Filipino, Hawaiian, and part-Hawaiian.

Because of the ethnic distribution of students, KCC's efforts to enhance the success of ethnic minority students involve sensitizing as many of the college's faculty as possible to the needs of ethnic minorities, with extra emphasis on underrepresented ethnic minorities. When faculty and staff are recruited they are made aware of the multi-ethnic, multicultural nature of the college's student body, and a desirable qualification for selection is being able to successfully work in a multi-ethnic, multicultural environment. Active recruitment of faculty from underrepresented ethnic minorities is also common practice. Professional development activities and faculty discussions on working with culturally diverse students are also encouraged and supported. With a sensitive cadre of faculty and staff, the college

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encourages collaborative work to create learning environments that meet students' personal, social, cultural, and academic needs so that they can develop a sense of place on the campus.

Positive Learning Environments

KCC has in place several learning programs that aim to enhance the success of ethnic minority students. One is the Hawaiian Studies Initiative, Hale Ho'oulu Na'auao ("the house that nurtures the growth of knowledge"), which makes a special attempt to help Hawaiian and part-Hawaiian students succeed in college. This program is staffed by a Hawaiian studies instructor, two Hawaiian outreach counselors, and Hawaiian studies lecturers. The staff teach; assist in recruitment and retention of Hawaiian and part-Hawaiian students; sponsor Ho'opa'a I Na Pono ("study that which is right"), a Hawaiian club that offers mutual support, leadership training, and social activities; provide academic advising and peer counseling; maintain Ka'ilipu'ali, a ridge where a living Hawaiian cultural center is located that helps Hawaiians identify with their heritage outside the classroom through planting and harvesting taro, sweet potatoes, medicinal plants, ti leaves, and other traditional crops; and coordinate Hawaiian activities among the Kaua'i community, KCC and other college campuses, Hawaiian agencies and organizations, and schools. One counselor is a native Hawaiian from the island of Ni'ihau located off the west coast of Kaua'i, where all the residents are Hawaiians who speak and write their native language. This counselor has been instrumental in recruiting first-generation college students from Ni'ihau for KCC.

Hawaiian and part-Hawaiian students find a support base in Hale Ho'oulu Na'auao from which they can more effectively deal with the rigors of college life. Enrollment of native Hawaiian students has risen dramatically with this initiative, representing an increase of 63 percent for vocational education students between 1986 and 1991, and 52.5 percent for the overall Hawaiian student body. In fall 1991 the number of Hawaiian and part-Hawaiian students enrolled in liberal arts, health services, and technology programs was 74, eight, and 21, respectively. The campus has also had early successes with Niihauan students. One young man who had been a welfare recipient was able, after graduation from KCC, to become a welder. Two women from Ni'ihau graduated from the Early Childhood Education

Program and went on to become a bilingual teacher for the Kamehameha Elementary Education Program and the director of a Hawaiian language pre-school, Punana Leo ("nest of language").

One other part of Hale Ho'oulu Na'auao is a Summer Bridge Program designed to assist underachieving Hawaiian and part-Hawaiian students in bridging or making the transition to college study. Strategies used in this bridge empower students to take pride in their diversity, to appreciate their own unique gifts and talents, to discover the relevance and importance of personal and cultural values, and to instill confidence in themselves such that excellence in their educational endeavors becomes their goal. Faculty from English, math, and Hawaiian studies work with counselors and learning center personnel on this project. The Summer Bridge Program served 15 students in the summer of 1991. Of this cohort, 11 students subsequently enrolled in KCC classes.

Another example is the KCC Nursing Program Minority Enhancement Efforts. These efforts seek to increase admission and retention of students at academic, social, and psychological risk (many of whom are underrepresented ethnic minorities) through coordinated efforts among nursing faculty, learning center staff, support course instructors, and the nursing counselor. Enhancement activities are directed at developing pre-nursing students who cannot meet nursing admission requirements and providing academic support once students are admitted into the nursing program.

Courses such as "Learning to Learn," "Computer Applications in Nursing," and "Modern Health: Family and Community" are offered to pre-nursing students to support their academic needs and provide exposure to health career concepts and the nursing faculty. This early exposure provides a comfort level for potential nursing students. Pre-nursing students are also referred to the learning center for collaborative learning groups in chemistry, nursing, etc.; special instruction in microbiology and anatomy and physiology; and Plato computer-assisted instruction in chemistry and microbiology to supplement classroom work. In addition, intense counseling is provided by the nursing counselor to help students overcome emotional and social problems.

Upon entry into the nursing program, usually through individualized contracts, at-risk students are placed into academically homogeneous enhancement groups. The enhancement groups serve as a social structure for student-to-student and student-to-instructor interaction.

This increased group interaction builds relationships and creates a "safe" environment that fosters student participation in the learning process. The nursing counselor keeps track of each student to assure compliance with items initially agreed to in the individualized entry contract. Meetings involving the learning center staff, the nursing counselor, and nursing staff are held several times a semester to discuss student programs and new actions. It is also possible upon departmental recommendation for deceleration to half academic load for students not succeeding with a full academic load.

The result of the pre-entry focus of the Nursing Program Minority Enhancement Efforts is that all or most of the nursing student slots are being filled. Many pre-nursing students, however, do not continue into the program. In the post-entry phase, two-thirds of the at-risk students successfully complete at least the first level of the program. In 1991–92 five out of 12 at-risk students moved on to the second level of the program, whereas previously none in this category would have succeeded.

Because of the large number of at-risk students interested in nursing and their difficulty in meeting the program's entry requirements, the nursing department recognized the need to work with potential students to strengthen their motivation and academic preparation. A tech prep relationship was aggressively developed with the high schools on Kaua'i through an American Association of Community Colleges grant; and nursing faculty co-sponsored Health Occupations Clubs in each of Kaua'i's high schools, started an Early Admission Nurses' Aide Program for high school students, and developed a Health Occupations Exploration Partnership with a local hospital and the Department of Education. At the other end of the spectrum, the nursing department developed an upward linkage with the University of Hawai'i at Manoa College of Nursing to bring bachelor's degree and master's degree programs in nursing to Kaua'i so that local nurses could continue their education without leaving the island. This linkage is meeting the need for upward mobility among the nursing professionals on Kaua'i, several of whom are KCC graduates.

A final example is KCC's provision for the underrepresented ethnic minority students who wish to pursue educational goals beyond what KCC can offer or in a discipline not offered at the college. Bachelor's and master's degree programs in nursing are offered through linkage with the University of Hawai'i. In addition, the college's Hawaiian outreach counselors, transfer counselor (minority emphasis), and

other faculty work individually with students to coordinate testing for those who transfer; conduct workshops for students considering transferring to institutions within and beyond the University of Hawai'i system; develop network extensions so that transferring students will benefit from maximum credit acceptance and professional support upon transfer; and conduct high school outreach to inform college preparatory students about college expectations.

The success of the college's assistance to these students is illustrated in the story of Melinda Domenden, a Filipina student from Kaua'i. Melinda graduated from Kapa'a High School, located approximately 10 miles east of the college, as the salutatorian of her senior class. She came to KCC to save money, spend more time with her family, and find out who she was and what she wanted to do. The community in which she was raised had few professionals in math, science, or engineering, so, although she was interested in science, she was not sure what her career options in this field could be. While at KCC she developed a special student-teacher relationship with her science and math instructors and was inspired to continue her education after graduation. Through the encouragement of one of her science instructors, Melinda applied and was selected for Haumana ("student"), a national program sponsored by the Pacific Biomedical Research Center of the University of Hawai'i at Manoa that enables underrepresented ethnic minority students to do biomedical research. This program enabled her to do investigative work and write papers that were presented at symposia in Florida and New Orleans. While in Haumana, she chose to major in biology at the University of Hawai'i at Manoa and received her bachelor of arts degree "with honor" when she graduated in 1987. Then, confident about her academic abilities and deciding she wanted to pursue a career in medicine, she applied to the University of Hawai'i at Manoa Medical School and was accepted. After four years of intensive work, Melinda received her medical doctorate. She is presently an intern in the pediatrics department at Kapi'olani Hospital working with women who have high-risk pregnancies and with infants who need intensive care. From 1986 to 1991, 61 students in math, science, and engineering transferred from KCC to the University of Hawai'i at Manoa. Of these, 18 were underrepresented ethnic minorities.

Recommendations

The Hawaiian Studies Initiative, the Nursing Program Minority Enhancement Efforts, and the provision for underrepresented ethnic

minority students who wish to pursue educational goals outside what is offered at Kaua'i Community College are but a few examples of how KCC is striving to assure student success through positive learning environments. KCC's efforts to enhance the success of ethnic minority students (1) work to make education a continuum from high school to graduate school and seek to help students get from any point in this continuum to a higher one; (2) attempt to involve as many of the faculty and staff as possible in all initiatives; (3) are not necessarily limited to specific disciplines such as mathematics, science, and engineering but, whenever possible, are directed at enhancing the success of ethnic minority students in all fields; (4) emphasize faculty and staff working collaboratively and in partnership with the community, schools, and other postsecondary institutions to help students succeed; (5) increase the time that students spend with faculty and on their course requirements; and (6) strive to create a non-threatening, highly supportive atmosphere for all ethnic minorities and their cultures. These key elements reflect core values of KCC in creating a campus attitude that guides the development of all campus efforts to enhance the success of ethnic minority students.

From KCC's experience, the following recommendations to enhance the success of ethnic minority students in the fields of mathematics, science, and engineering at community colleges are made.

- National policy-making bodies should broaden rather than limit the scope of initiatives to enhance student success. Initiatives can be designed to meet the needs of one ethnic group or discipline but include as many other students as possible, because what works for one ethnic group and one discipline would probably work for others, and integration should improve outcome.
- Initiatives to enhance the success of ethnic minority students should start with the development of a desired campuswide attitude that would create the type of learning environment that would foster student academic success. This attitude would provide the common theme for all campus initiatives.
- The initiatives should strive to create a non-threatening, highly supportive atmosphere for ethnic minorities and their culture.
- The initiatives should increase the time that students spend with faculty and on their course requirements.
- To the extent possible, the initiatives should be oriented to students' needs, with an interest in fitting into students' educational

objectives rather than fitting students into a particular college program.

- The initiatives need to pool campus resources and extend to high schools as well as other postsecondary institutions. Campus faculty and staff need to work collaboratively to develop effective learning communities that expand beyond the classroom and beyond the college.

Appendix

Other University of Hawai'i Programs that Enhance the Success of Underrepresented Ethnic Minority Students

Health Careers Opportunity Program

The Health Careers Opportunity Program provides support services to disadvantaged, non-traditional undergraduate students pursuing health, medical, or allied health careers at the University of Hawai'i at Manoa and the University of Hawai'i at Hilo. Participants receive year-round academic advising and guidance, information about health careers, and assistance with entrance requirements and scheduling of prerequisite courses. Eligible students may participate in a free summer program consisting of field visitations to medical facilities, speaker sessions with health professionals, "shadowing" activities, and academic homework.

College Opportunities Program

The College Opportunities Program (COP) is a statewide program for any resident of the state who thinks low SAT scores, limited college preparation, and/or economic difficulties will prevent him or her from attending the University of Hawai'i at Manoa. Priority is given to individuals who come from ethnic backgrounds that are underrepresented on the campus as well as those individuals who are rejected for regular admission. Selected students participate in a two-part program. In part one, a summer residential-instructional experience on campus develops academic and social skills necessary to be a successful freshman and sets a performance standard to gain entry to the University of Hawai'i at Manoa. In part two, entry into the

University of Hawai'i at Manoa as a full-time freshman with priority dormitory space is provided to all selected students who have met the summer performance standard. COP provides coordinated student services and supportive activities to all program students during their first two semesters at the University of Hawai'i at Manoa.

Operation Manong

Operation Manong ("older brother") provides part-time employment, training, and multicultural field experience to university students while assisting minority students in the public schools. Its primary goal is to recruit and retain Filipino and other minority students who are underrepresented at the University of Hawai'i. Operation Manong also coordinates special programs, such as the University of Hawai'i Community College-Manoa Transfer Project, the Prefreshman Enrichment Project, and the Hawai'i Pregraduate Program.

Hawaiian Leadership Development Program

The Hawaiian Leadership Development Program at the University of Hawai'i at Hilo recruits talented Native Hawaiians and facilitates their academic and leadership development. The program addresses the need for assisting Hawaiians in attending and completing postsecondary programs, providing training to develop students' leadership potential, and increasing the number of Hawaiian leaders in professional fields and in the general community. Activities of the program are designed to develop each participant's potential. The program requires participants to enroll in courses that facilitate their personal, academic, cultural, and leadership growth. (Classes are offered in human development, Hawaiian language, and Hawaiian leadership.) In addition, structured out-of-class activities augment the program goals through scheduled study times, tutoring, peer counseling, mentor-student relationships, and leadership experiences through a myriad of options. Students facilitate meetings, plan exhibits, work on community projects, help with a leadership conference, attend off-island workshops, and learn further leadership skills through an on-the-job internship program.

Hawaiian Vocational Education Assistance Program

The Hawaiian Vocational Education Assistance Program assists Hawaiian and part-Hawaiian students enrolled in vocational-technical programs at Kaua'i Community College. Students are provided with academic support, career and personal counseling, assistance in filing for financial aid, and other services to ensure a successful education. Information on and orientation to campus and community programs and resources, study skills, and personal growth workshops are also available. Full-time college students are hired as peer counselors or tutors to assist in providing these services during the school year as well as during a special six-week summer program on campus. Basic math and reading and a Hawaiian values class are offered during the summer in preparation for the coming school year.

Po'okela

Po'okela ("highly skilled person") provides support services for native Hawaiian students to succeed in their college studies at Maui Community College. Hawaiian students may walk in for personal, academic, and vocational counseling and get help in locating and applying for financial aid.

Operation Kua'ana

Operation Kua'ana ("older brother or sister") seeks to increase the enrollment and graduation rates of Hawaiian students at the University of Hawai'i at Manoa and to promote camaraderie among them, thereby perpetuating the true meaning of aloha ("love") and ohana ("family"). Support services include writing, computer, and research workshops; study groups; tutoring; and assistance with financial aid applications.

The Lokahi Project

The Lokahi ("unity resulting in harmony") Project provides tutoring and academic, career, and personal counseling to native Hawaiian students at Kapi'olani Community College. Other services include identification of sources of financial assistance as well as referrals to

a network of campus services designed to help the student succeed in college.

Minority Student Affairs

Minority Student Affairs conducts research and training programs on teaching and learning relevant to minority students, develops grant proposals, and coordinates and supports minority student projects, particularly for the smaller ethnic groups on the University of Hawai'i at Manoa campus (e.g., African Americans, Samoans, and Southeast Asians). It also provides coordination for minority student programs at the University of Hawai'i at Manoa, as well as systemwide.

DANIEL WILDCAT AND EDWARD NECEFER

A Native American Model

TEACHING NATIVE AMERICAN STUDENTS AT THE COMMUNITY COLLEGE level is challenging and very rewarding if effective instruction is given. More than any other minority group, Native Americans can claim to be the least understood and most ill-served by typical pedagogical approaches to math instruction. According to the National Center for Education Statistics (1988), Native Americans have the lowest American College Testing scores and the highest high school dropout rates in the United States. This classroom failure, combined with the overrepresentation of Native Americans in the lowest economic levels of our society, makes it all too clear why so few Native Americans pursue careers in the field of science.

The key problem in providing minority students the mathematics preparation they need to successfully pursue degrees in scientific and science-related fields is not the students themselves or the subject matter: it is the failure of colleges to structure a program whereby creative teaching methods can be applied.

Many Native Americans who are successful in completing high school enter postsecondary institutions academically unprepared for rigorous college science curricula. Community colleges must face the challenge of creating programs of instruction whereby these ill-prepared students from underrepresented minorities in the fields of science and technology can be prepared for the rigorous courses of study required in these fields.

Haskell Indian Junior College (HIJC) is meeting this challenge by undertaking a systematic restructuring of its math instruction program. Troubled by the high failure rate in its mathematics program, and the low self-esteem and increased dropout rate associated with this failure, the math faculty at HIJC decided to structure a math program for student success. The faculty's goal was to create a program with high academic standards that not only would seek

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to use Native American-related material in the classroom, but would fundamentally draw its organizing principle from Native American worldviews.

In short, the math faculty at HIJC have looked beyond the exclusively rational and logical world of mathematics to explore humanistic and holistic approaches of knowledge delivery to Native American students. Central to this approach is the recognition that Native American worldviews emphasize the importance of grasping the "big picture" before one sets about studying particular things or subjects. The importance of particular activities or specific knowledge is defined by how these activities or this knowledge fits in the big picture or in what John Mohawk (1988) has described as the "complex web of life." The complex web of life refers to a complex set of relationships—social, biological, and metaphysical—that define one's existence and give meaning to particular aspects of one's life. An important component of successful math instruction for Native American students is transforming the learning of mathematics from a purely abstract logical exercise to a subject with a history and applicability to the complex web of life.

HIJC's Mission

Haskell Indian Junior College is located in Lawrence, Kansas, and is one of the oldest government-supported schools in the United States. Established in 1884 to fulfill treaty and trust obligations, HIJC has become a nationally recognized intertribal institution of higher education for more than 100 Indian nations from over 30 states. HIJC has evolved from an elementary school, to a trade and high school, to a vocational-technical school, and finally, in 1970, to a fully accredited junior college.

More than 800 Native American students attend HIJC and have the option of pursuing an associate of arts, associate of science, or associate of applied science degree. HIJC's mission is to provide (1) a high quality education that prepares students to meet the challenges of a changing and multicultural world; (2) programs that are responsive to the diversity of the student body and dedicated to the total development of each individual; and (3) programs that support the study and appreciation of American Indian and Alaskan native cultural values.

Until recently, most instructors at HIJC initially had a general lack of knowledge and understanding of Native American cultures and contemporary issues. Consequently, instructors had difficulty appreciating and teaching the relevance of mathematics to Native American peoples.

Learning Aptitude and Instructional Relevance

Native Americans have made significant contributions to the world of mathematics (Closs, 1990). Well before the arrival of Christopher Columbus, many Native American tribes had recorded number systems and calendars that applied to daily life. In fact, Native Americans made tremendous contributions to European and world development (Weatherford, 1988). Yet most of this knowledge is not used in classrooms, especially in science and math classrooms, where the ahistorical character of instruction continues to rely heavily on abstract logic to teach math. The role of intuition in teaching mathematics is even downplayed and generally avoided (Anderson and Stein, 1992).

No wonder the subject of mathematics seems foreign to Native American students. The subject falsely confronts them as something that they, as native students, must lack in aptitude to understand. They conclude mathematics unimportant and unrelated to their own culture and, like far too many students, fail to see the relevance of the subject to their own lives in modern society.

. Understood in this light, the first challenge math instructors of Native American students must face is to create a classroom environment in which mathematics is seen as relevant and meaningful. Studying math just for the sake of studying math is foreign to Native American cultures (Megginson, 1990). Native American students have to be convinced that mathematics relates to their life, or they will avoid the subject and/or refuse to fully participate in the learning process (Green, 1978).

Cultural sensitivity to Native American values and behavior is crucial to successful classroom instruction. Direct eye contact, competitiveness, and boasting about oneself are taboos among most Native American peoples (California State Department of Education, 1991).

Methods of instruction must be evaluated to conform with the learning style of Native American students. For the past 300 years

mathematics has been primarily taught using the lecture approach. Math instructors typically lecture and work out sample problems during class. Students work on assignments out of class. Unfortunately, this approach is ill-suited to the learning style of Native American students (Rhodes, 1988).

Native American students prefer group-oriented learning environments and view group cooperation and harmony as more important than the success of one individual (Anderson and Stein, 1992; Rhodes, 1988). Consequently, instructors can initially expect less verbal participation and eagerness to contribute in class. An instructor comfortable with long silences and willing to gradually encourage participation will develop trust and rapport with native students. Once gained, this trust will guarantee increased classroom participation by Native American students.

Finally, the limited amount of required contact hours in the classroom and lack of professional Native American role models in the field of mathematics are contributing factors to the poor success rates of Native Americans in mathematics. Most Native Americans enter postsecondary institutions underprepared in mathematics. Colleges must find creative ways to prepare these students. To throw underprepared students into a college-level class and tell them to sink or swim is morally and educationally irresponsible.

Two issues converge here that suggest that colleges might need to throw out artificially time-bound conceptions of learning. First, it does not make sense to have at-risk students who have been failed for years by formal instruction in mathematics to make up their lost years in a semester or two. For instance, students placing in a typical three-credit/contact-hour, pre-college-level "Introduction to Algebra" course may get through the class but will not necessarily retain concepts needed for the next higher-level course. As a result, the students become bogged down in the review of concepts and topics they should have mastered in their previous course. By the end of the semester these students will be again behind and not getting all the concepts they will need to be successful in their next higher-level math course.

Second, the learning style of Native Americans does not fit a time-bound notion of learning. The Native American approach to learning encourages one to learn by doing and admonishes one to be patient if a task at hand is not accomplished on the first try.

Finally, the lack of professional Native American role models in mathematics often contributes to stereotypes Native American students may have of non-native mathematicians from the dominant society (Megginson, 1990). Native students often perceive mathematicians as calculating, obsessive, sloppy, isolated, and interpersonally out of touch with the real world. This image directly conflicts with attributes Native Americans value.

During the 1980s HIJC's mathematics department became increasingly dissatisfied with the high failure rate in its classes. The failure rate was well over 50 percent, and in the upper-level courses it approached 80 percent. The department was embroiled in a dispute over teaching effectiveness. There were complaints that not enough was being done to help the students succeed. After much frustration, the instructors decided to revise the entire math program.

In order to create a successful learning environment for mathematics at HIJC, all math instructors were advised to incorporate Native American-related materials into their courses. In addition, all non-native instructors henceforth were to stress the advantages of Native American values in the learning process.

Course syllabi were altered to reflect the needs of Native American students while still retaining academic integrity. Instructors were encouraged to attend national mathematics conventions as a way to instill enthusiasm and generate motivation, and to share ideas learned at these meetings with other faculty members in the department.

The "Introduction to Algebra" course became a five-credit/contact-hour course as opposed to a three-credit/contact-hour course. The extra two contact hours provided more time in which to review, as well as more time in which to teach new material. A few students complained, but overall students began to realize they needed all the help they could get.

In the fall of 1991 the HIJC math department instituted departmental finals for its two pre-college courses: "Introduction to Algebra" and "Intermediate Algebra." Students failing these minimum competency exams must retake the course. The implementation of this final examination policy brought about two significant behavior changes in the students and instructors. As a result of understanding very clearly what it meant to be successful in these courses, more homework was completed and more after-class hours were devoted to math assignments. Instructors also put in more after-class hours. They spent more time developing lesson plans, review sessions, and tutoring

strategies to encourage student participation in a culturally sensitive manner.

Instructors developed a broader array of instructional methods, employing cooperative learning techniques. As Lee Little Soldier (1986) states, "Cooperative learning matches traditional Indian values and behaviors: the harmony of the group supersedes the importance of the individual" (p. 162). Through cooperative learning, students help one another. In the absence of the fear of appearing wrong or stupid to their teacher, students seem more willing to tackle problems and ask questions when working in groups.

Finally, math instruction was supplemented with a well-organized and much utilized tutorial program. The math tutorial program, which operates six days and five nights a week, offers students computer-assisted instruction, math videotapes, peer tutoring, and individual one-on-one tutoring with professional math tutors. Of these services, the peer tutoring program has been the most popular and successful. The tutoring center recruits peer tutors from the higher-level math courses, such as calculus, pre-calculus, and college algebra. Math peer tutors are students with A or B grades who display a desire to help others and a bountiful amount of patience.

The peer tutoring program has helped not only the students needing tutoring, but also the tutors themselves. Peer tutors have increased their skills and their interest in math- and science-related careers. Also, with so few Native American role models available as math and science faculty, these Native American peer tutors function as positive role models for students.

Early indications are that these changes have produced positive results. The "Introduction to Algebra" department final has been given twice. In the fall slightly more than 50 percent of the students passed the finals; in the spring 70 percent passed. Maybe more important than the increased rate of success at this level was the fact that the students who passed the final demonstrated much better preparation for the "Intermediate Algebra" course. Less time was spent reviewing concepts at the "Introduction to Algebra" level because students had a better retention of what they had just learned. Instructors were able to cover all the topics in the "Intermediate Algebra" syllabus because the students did not require a prolonged review of introductory-level concepts. Consequently, one of the main problems the department faced—the maintenance of academic integ-

rity of math courses throughout course offerings and sequence—had greatly improved.

Meeting Academic Expectations

It is unrealistic to expect Native American students to make up for 12 years of neglected or failed math instruction and immediately complete college-level math courses. Yet this is exactly the way most colleges treat underprepared students. The human mind and intellect is much more complicated than the mechanical apparatus of an automobile. Nevertheless, an analogy to the way we treat these students would be to take an unmaintained 12-year-old automobile that has seen little use and decide to immediately drive it again at highway speeds. Of course, the automobile would break down. We would expect it to. Any reasonable person would get the car inspected, provide a complete mechanical tune-up, and then initially drive the automobile slowly and carefully to see if any problems arise. Any reasonable person would do this with an automobile; yet we fail to give the same attention to the neglected and little-used intellects of Native American students when it comes to math and science education.

Native American students can meet high academic expectations if they are given the opportunity to have their skills assessed, get a tune-up, and most important, learn in a program that is not strictly time-bound. It may take more time for them to get up to speed, but if they are striving hard and learning the material, why fail these students? Colleges must look at ways to create in-progress grades. In short, they should look at ways to extend courses for students who need more than three contact hours a week for 15 weeks in order to get through college algebra.

Skills of incoming freshmen must be assessed independently by math departments. Given the problems of grade inflation and social promotion that many minority students face, high school transcripts often prove unreliable. Community colleges must be willing to provide academic preparation courses in the areas of math and science. Colleges must be prepared to give all underprepared students the time needed to develop math maturity. Haskell Indian Junior College currently provides three levels of preparatory mathematics below college algebra.

Outside class assistance must be made available. After-class contact hours are crucial to student success. When possible, peer tutors should be used in paid part-time positions through tutoring centers.

Most important for Native American students, mathematics must be put in the "big picture" if they are to see the study of mathematics as relevant. Relevance is not something they are willing to take for granted. In fact, as noted previously, the notion that one would accept the importance of mathematics without seeing it connected to the complex web of life is conceptually foreign to Native American students. Some HIJC math faculty have even begun requiring students to do written reports on the connection of mathematics to their own tribal traditions or to Native Indian contemporary issues in order to help make this point.

Native American-related information must be included in math instruction. Without it, many Native American students will continue to perceive math and science as foreign to their own culture, even fundamentally hostile to their worldviews.

It is known that Native American students respond to warm and caring classroom environments (Kleinfield, 1975). But make no mistake about the absolute necessity of maintaining rigorous programs with high academic standards. Ultimately, that is what minority students will need if they are going to succeed in scientific and science-related fields. It is obvious minority students are often victims of programs that expect them to run full speed without any concern for their preparation. It is also known that many minority students are victims of what is called the "missionary complex." The missionary complex is seen in the well-intentioned teachers who want to save our students by lowering standards and, unwittingly, expectations. They know all too well the many reasons why minority students cannot possibly be expected to work at a level commonly expected of mainstream students. The result of this attitude is just as devastating to the future success of Native American students as the insensitive attitude of those who espouse high expectations and standards but fail to offer ways for students to meet those standards. In short, community colleges must hold high and rigorous standards for math and science programs, but must create instructional programs whereby students have an opportunity to meet those standards.

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KARLA ALVAREZ

Motivating Minorities to Pursue Mathematics, Science, and Engineering Careers

WHY IS THERE SUDDENLY A BIG SCARE IN THE UNITED STATES REGARDING the decreasing number of minorities and women in the fields of mathematics, science, and engineering? Why is the existing group of White American male scientists, engineers, and mathematicians not living up to the technological levels of the twentieth century? What can be done to increase the number of mathematics, science, and engineering professionals among ethnic minorities in the American work force?

This paper addresses these questions and proposes some solutions.

In the past, the United States has depended on a predominantly White male population in the mathematics, science, and engineering fields. However, the status quo is changing. The White males that dominated these fields are now getting old and retiring, and fewer and fewer younger White males are following in their footsteps. Studies have shown that they are instead opting for the new-found lucrative fields of business, marketing, and law where mathematics and science skills are not critically important (Gallon, 1990). As the traditional White male work force moves away from mathematics and sciences, the United States is forced to search within its populace for another source of workers to fill the positions.

According to the federal Bureau of Labor Statistics, ethnic minorities are quickly becoming the majority in the workplace. With projected heavy demands for electrical, industrial, and mechanical engineers, businesses will be searching for minorities and women with strong scientific skills. These trends leave the door open for minorities and women to rush in and take over employment opportunities that in the past were not available to them. Unfortunately, synonymous with the defection of White males from technological professions is

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the decline not only in the percent of minorities entering into these fields, but more depressingly in the number of minorities who actually make it through four-year college programs.

Although the number of minorities enrolled in secondary and graduate programs in mathematics and sciences has increased over the past decade, enrollment figures do not accurately reflect the number of students who complete the programs. In addition, despite the increase in employment of minorities in 1986, to this day they are still underrepresented. This fact is reflected in low participation in pre-college, undergraduate, and graduate science and engineering courses by ethnic minorities. According to the director of the Accreditation Board of Engineering and Technology, minorities are more likely to enter technician rather than engineering programs because the level of mathematics and science required is lower (Feuers, 1990). This statement in itself is a testimony to the need to increase the mathematics and scientific literacy of students in order to assure a greater, competent professional work force tomorrow.

The future of the United States lies in encouraging the up-and-coming minority labor force to embrace the mathematics, science, and engineering fields. An unskilled work force yields an innovation-poor industry, which results in a sinking economy and a decrease in demand for American goods. If this trend should continue, the United States will become the Great Importer, dependent on other nations for technology and products. If the United States is to recover its high standing in the world order, other than that of military superpower, it must focus on human resource development, particularly through the education of its work force.

Motivating Minorities

Why are minority students not pursuing technological careers? Based on conversations with other minority professionals who have made it through the system, following is a consensus of reasons for the lack of interest and motivation of ethnic minorities towards mathematics and science professions.

I am often asked, "What does a civil engineer do?" Good question. But if something as fundamental to society as civil engineering is a mystery to the common worker, how can anyone expect students to pursue such an enigmatic career?

Minority students are not exposed to many technical personalities. Unlike the sports and business fields, the science and technological fields tend not to promote exposure to the outside world. Before 1990 the National Aeronautics and Space Administration (NASA) was the most prominent technological force in the world. NASA provided role models of successful minorities. Since the Challenger disaster, however, it seems as if scientists, mathematicians, and engineers have noticeably disappeared from the headlines and are keeping a low profile. In this day of media overexposure and hype, positive technological role models are sadly absent.

Traditionally, mathematics and science learning skills were based on repetition and memorization. Year after year these techniques were enforced until students followed suit and realized that as long as they could recite the correct answer, they would advance. Unfortunately, repetition and memorization became synonymous with teaching. No active thinking was required during the teaching process. The impression that learning mathematics and science was dull and boring was reinforced in the minds of students. Very few students were motivated to try to understand the concepts behind the theorems. Mathematics and science, for many students, became a mystery that remained unsolved.

Whenever new concepts were introduced, old techniques of memorization were employed. When there was the slightest change in the theorems, the subjects became confusing and difficult because there was no comprehension of the basic concepts.

This attitude has also been reinforced at home by parents who routinely tell their children to study and yet offer no help in explaining concepts. Most of these parents were also victims of the memorization-without-comprehension syndrome. It is not surprising that students do not choose mathematics and science professions that require significantly higher levels of comprehension.

Sadly, students who might contemplate pursuing a career in engineering are discouraged. They see the task as unattainable and too difficult. They lack the self-esteem and confidence to take on the challenge of more intensive mathematics and science studies.

The concept of an elitist society of intellectuals holds a special fascination for some individuals today. This notion is encouraged by the teacher who pays special attention to the student who dares to pursue comprehension of the basic concepts. Eventually, the formation of advanced placement programs separates such students from

their classmates. This practice creates an illusion of isolation and segregation. The notion that mathematics and science are only understandable to a talented few is also promoted by educators' special treatment. Those students who have the intuition to pursue such fields are labeled as "nerdy" and "uncool." The math-science elite stereotype is of a highly intelligent, hard-working individual who does not know how to have fun. Possibly late bloomers and students uncertain about career pursuits are immediately turned off by this stereotype. Peer pressure and the fear of isolation often drive such promising students away from mathematics and science fields.

The main reasons, then, for the decline in the number of minority students in mathematics- and science-related fields are lack of comprehension of the basic concepts of mathematics and science, low self-esteem and confidence in dealing with mathematics and science studies, and lack of positive role models from mathematics- and science-related fields. These deterrents are a result of years of neglect and apathy toward the American education system by industry, government, and its citizenry. This damage cannot be undone quickly enough to save generations of wasted minds.

Positive Learning Environments

Developing and implementing programs that focus on these major issues would help increase interest in, and attract more minority students to, mathematics and science professions. Such programs, at the very least, require a rehauling of the current education curriculum, from pre-school through graduate school, at both local and national levels, and the active involvement of businesses, industry, and professional societies in partnership programs.

Revising the educational curriculum is a Herculean task. Since students cannot easily unlearn methods that they have already taken to heart, the only recourse is to build upon these skills and help to develop new and more comprehensive skills. The revised teaching style should not discourage memorization, but rather encourage comprehension and problem-solving skills. It may well be necessary to provide additional tutoring for students in order to achieve this level of comprehension. Tutoring should be encouraged for students at all levels. This attitude would lessen feelings of inferiority often associated with seeking additional help in studies. Tutoring sessions should be promoted as a sharing of information rather than as an imparting

of data. Even this slight distinction can alter the psychological perception of a student requiring additional aid.

As students begin to develop comprehension techniques, tests such as the American College Test, Scholastic Aptitude Test, and timed multiple-choice tests, which encourage quick-thinking and recall skills, should be phased out. These skills are of little or no use in mathematics, science, and engineering fields. Achievement tests should be revised to emphasize problem-solving skills. It is true that performance tests are more expensive and time-consuming to grade, but they will send an important message to students, that comprehension of the concepts is essential in order to advance. In the long run, all students will be developing the skills applicable to mathematics, science, and engineering fields. Also, the reduction of dependency on memorization skills will minimize the dull, repetitive nature of the learning process, encourage innovative thinking, and develop intuitive thinking patterns. Another benefit will be the realization that active learning and hard work can be worthwhile and fun. This notion can later be translated to a search for careers in mathematics, science, and engineering (Coes, 1990).

As students develop a better understanding of the concepts behind mathematics and science, at a minimum the level of literacy at which the basic concepts are understood becomes the standard and not the exception. The aura of mystery around and resentment toward mathematics and science will be dispelled, taking with it the helplessness and confusion often experienced by students. Under these circumstances, late-bloomers and students who might be interested in mathematics and science would not be turned away by advanced placement programs. As the gap between comprehension of the basic concepts of mathematics and science and the current level of comprehension required by advanced placement programs narrows, the stereotype of the mathematics and science elite will become less foreboding.

The best way to build up self-esteem is to reward and encourage achievement. With regard to understanding mathematics and science, it is important that educators and parents are trained to motivate, challenge, and support student efforts, no matter how small. Teachers and parents will have to be retrained to stay away from the traditional teaching style of having all problems solved by one tried-and-true method. In order to encourage active thinking, teachers will have to evaluate and identify each student's individual needs and teach according to individual learning styles. This will not be an easy task

and will require additional effort from the teaching staff. Encouraging students to explain their solutions allows peers as well as teachers to take part in the active learning process. This means that more time will be spent on subjects that previously may cursorily have been looked over. Parents and school administrators must be made aware of what the teachers are trying to achieve, so they can help maintain a supportive environment at home as well as at school (De Van Williams, 1990).

Raising achievement levels will not be easy. Constant and increased efforts and support from all responsible parties are needed. Teachers should be retrained to expect more from the students and should not be hesitant to implement a more demanding curriculum. Teachers should make sure that each student can explain his or her solutions, and the student should be rewarded or praised for this achievement. Building encouragement and support on small successes may eliminate the fear of failure so often associated with mathematics and science courses and thereby foster hope of success in mathematics- and science-related careers (De Van Williams, 1990). In the long run, early investment while students are still in school will be a cheaper burden for the U.S. economy than ignorance, unemployment, and dependency.

One such program that emphasized learning rather than teaching was the E^3 program developed by T. Paul Torda in 1971 at the Illinois Institute of Technology under funding from the National Science Foundation. The program was designed to educate undergraduate engineering students to be creative problem solvers. The standard teaching practices of lectures, notes, homework, quizzes, and exams were replaced by the encouragement of self-paced independent learning. Teachers became mentors rather than didactic lecturers. The goals of the program were to increase the students' level of motivation for continuous independent learning; develop their problem-solving skills; allow them to evaluate the quality of their own work; and give them the opportunity to work in teams and learn to communicate among themselves and with their teachers.

This shift from teaching to learning was very successful. Although the program focused on engineering undergraduates, there is no reason why a similar program could not be implemented throughout the entire education system. In the beginning, the amount of time spent in free learning would be kept short and would gradually increase until the majority of the course hours was spent in learning

at individual levels. Teachers would still expect course matter comprehension from all students. A gradual infiltration or adaptation of active learning programs into the current education curriculum may be just the boost needed to revitalize and motivate students and teachers alike toward mathematics and science (Torda, 1971).

In order for any of the above-mentioned reforms to be implemented, adequate funding has to be made available. Increased efforts by teachers and administrators, retraining programs, revised curricula, additional tutoring programs, and revised testing programs will cost money to perform and produce. The current weak education budget will have to be boosted. State and federal agencies will have to put the future of America first and rework the budgets to provide funding for the changes and upgrades that are necessary to bring the country back to a level comparable with the rest of the world in education and technological innovations.

On a strictly dollars-per-student basis, these reforms may not be viewed as cost-effective, but the alternative is the much higher cost of wasted brain power. How can a price be put on an educated citizenry? To truly realize the cost-effectiveness of these reforms, a long-term rather than a short-term evaluation of the benefits should be examined (Torda, 1971). The United States has already suffered from the short-sighted outlook on education. Only a long-lasting solution will be of any help now. Utilizing available human resources, through partnership programs, may be one way of keeping down the cost of enhancing mathematics and science interests among minority students.

Partnerships with Business and Industry

Role models are perhaps the most effective way to motivate minority students to take interest in mathematics, science, and engineering fields. The power of the influence of role models on American society is evident in everyday life. Business and marketing executives have capitalized on this concept over and over again. The most obvious example is in the world of sports. The mere existence, constant visualization, and exposure of sports figures like Bo Jackson and Michael Jordan reinforces the notion to young and old that higher levels of achievement are attainable in that field. The psychological impact on impressionable minorities is tremendous. Not only has one of their 'own broken into the field, but he is also successful. This thought

pattern develops into thinking, "Hey, I can do that too." This is the type of thought pattern that is needed to motivate students to pursue careers in mathematics, science, and engineering.

The primary goal of partnership strategies is to enhance interest and achievement of minorities in the mathematics and science fields by providing role models. The two levels of partnerships recommended are between the different class levels within the education system and between schools and business, industry, and professional societies. This two-fold plan is an excellent way to utilize existing creativity and spread it throughout the education system.

University/high school partnerships, mechanisms that can be used to provide role models, have been around since the late 1970s in one form or another. One example is the summer program at Cooper Union in New York City. Undergraduate engineering students worked for the university as math tutors to high school students enrolled in a free summer math program for interested minority students. The contact between potential engineering students and current undergraduates was very beneficial. Students were able to find out more about what mathematics and science in engineering school was like and what one did with an engineering degree. The students were able to communicate with someone like themselves who made it to the next academic level. There is no reason why partnerships have to be limited to university and high schools. Each higher level of education should form a partnership with the level or class directly beneath it (e.g. undergraduate and secondary, secondary and primary, and primary and pre-school).

These relationships should include programs designed to re-educate teachers as well as students. Such programs should enable students to experience how mathematics and science have influenced the next education level and also provide minority students with successful role models. All too often students who might contemplate mathematics and science fields are psychologically defeated when they cannot picture themselves in those fields. Intrascholar partnerships can provide role models every step of the way through the educational process and give students at all levels something to emulate. This added psychological boost will help students build on developing confidence and self-esteem needed when entering mathematics, science, and engineering fields. Partnerships should incorporate activities such as tutoring, coaching, information exchange, lectures, passive or active participation in experiments, visits, and other active learning sessions, as well as an open door policy, so that students can feel free to ask questions about curricula and experiences.

The second type of partnership program that should be pursued is one that forms alliances between schools and business, industry, and professional societies. In the long run, business, industry, and professional societies will benefit directly from any time spent on increasing interests among minority students in mathematics and science. They should be urged to form partnerships with local schools at every level, not just at the university level. It is particularly important to form these relationships at the pre-college level because this is the point at which the student is thinking about a career and deciding a course of study. Clearing up misconceptions at this stage and providing the right influences could be very beneficial in helping students decide on a career path. Partnership activities should include mentor programs, information exchange, field trips, and lectures for teachers, administrators, and parents, as well as students.

Students and teachers who come in contact with engineers, mathematicians, and scientists, who use mathematics and science principles during everyday activities, will develop a better appreciation of how mathematics and science can help one succeed in life. This information and outlook will eventually filter through to fellow students and teachers, help in increasing interest in mathematics- and science-related careers, and motivate learning in these fields.

Two existing programs—the Semiconductor Research Corporation Competition Foundation (SRCCF), based in Research Triangle Park, North Carolina, and the Southeastern Consortium of Minorities in Engineering (SECME)—have used corporate and government assistance to form summer programs for teachers. Under SRCCF, teachers are involved in training sessions in which they are exposed to the latest in technology, visit manufacturing and research companies, and talk firsthand with technicians. The hope is that these motivated teachers will interest their students in such technology. In the SECME program, high school teachers are trained to link science, mathematics, and English with real-world applications in hope that this training will be transmitted to students. SECME also sponsors competitions and scholarships in problem-solving activities to motivate and challenge minority students (Chen, 1990).

Both types of partnerships provide benefits for students, the education system, and business and industry. More important, the United States will reap the greater benefits in the long run.

Students will be motivated to pursue careers in technological fields from working with other students currently studying mathematics

and science and by coming in contact with professionals already working in the mathematics, science, and engineering fields. The fears, uncertainties, and mysteries associated with mathematics and science will be eliminated. Students will be forming relationships and contacts that can be a valuable resource in their future careers.

The schools, from pre-school to universities, will also have benefited from establishing and maintaining partnerships within the education system and with business professionals, not only by increasing the production of motivated and challenged students and potential graduates, but also by revitalizing teacher education through in-house retraining. It is important to note that teachers become role models for their students. Therefore, creating an environment that encourages, motivates, and trains teachers as well as students, with regard to the technological advancements in mathematics and science fields, will no doubt yield motivated and focused students.

By taking an active part in motivating and educating students and teachers about the realities and successes in mathematics and science fields, businesses are shaping the quality and the mindset of the work force for the future. Businesses benefit by making potential employees aware of their services and their existence. Professional societies benefit in a similar fashion, ensuring that they do not become extinct while raising the quality and quantity of future professionals.

Despite all the benefits that can be gained from the implementation of partnerships, there are some pitfalls that implementers should avoid. To ensure that businesses are not using this opportunity only to ensnare potential employees, a system should be devised to screen the programs set forth by businesses. All participants should be given the chance to learn, not solely promising potential employees. In addition, there should be a formal commitment between partners, so that the system is maintained and not abandoned at the first sign of trouble or inconvenience. Such an outcome would only defeat the purpose of partnerships and take away from the students, teachers, and administrators an equal opportunity to experience the wonders and creative energy of mathematics and science in action (Chen, 1990).

Program Evaluation and Restructuring

Once the recommended programs have been implemented, a system for monitoring their effectiveness should be set in motion. The results of the periodic monitoring reports should be constantly evaluated in

order to identify successful programs and revise or eliminate the ones that do not work. These evaluations should not be broad and generalizing, but should be viewed with an individual regard for local and particular circumstances. Constructive changes should be implemented immediately and monitored continuously. This interactive process will help to fine-tune the system.

The system should be ever-changing, because in order for the programs to remain effective, they must change and grow with the times. Education models should not be static, but instead should be as fluid as life itself. Education should complement the life for which it is preparing its students. The committee responsible for monitoring the progress of the reformed educational system should include teachers, administrators, business professionals, and parents. The communication and feedback from these various members of the community can only enhance the system.

In order to minimize the sharp decline of ethnic minorities entering mathematics, science, and engineering fields, and to encourage minority interest, the education system should move away from teaching and toward learning. Such a change will require that the currently failing curriculum and teaching practices be systematically revised, over time modified, and eventually revamped. Students should be encouraged to comprehend concepts rather than memorize them. An environment that encourages and supports students to develop a greater yearning for achievement and increased self-esteem by making the most of challenging problem solving and active learning sessions should be implemented. The use of partnerships within all levels of the education system as well as with business, industry, and professional societies should be encouraged. The partnership programs should focus on retraining and exposing teachers, administrators, parents, and students to current technological innovations and career options.

The restructuring of the education system will not be a simple task, but it is necessary. The vitality of the U.S. technological lifeline is at stake. Mathematics and science enhancement programs will have to be phased in at all educational levels, from pre-schools through universities. Increased funding will be needed to achieve the necessary changes. Congress has to be made to understand that it is no longer acceptable to cast the American educational system aside. Funding will be required, not only to put the revised programs in motion on a nationwide scale, in both urban and rural settings, but also to keep them going and growing.

The American people will be the greatest benefactor of a revamped education system. The overall result will be an increase in minorities

headed for careers in mathematics, science, and engineering professions and an overall higher level of competency and innovative spirit. All these factors should eventually enable the United States to regain a prominent standing in the world's arena with regard to education and technology.

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AACC Senior Vice President Connie Odems and Bernard Charles, senior vice president of Quality Education for Minorities Network, join in the Roundtable discussion.

B. D. Mayberry

The Tuskegee University Model

As late as the 1960s, there was only one African American forester in the United States, and it was widely believed that African American youth were not interested in careers in forestry and natural resources. Without role models, without financial support and social encouragement, they lacked the motivation to enter these fields. That is, until the Tuskegee Institute (now University) in 1968 initiated a pre-forestry program in which students study career orientation and such basic fundamentals as communication, mathematics, chemistry, and physics for two years and then transfer to professional forestry schools to complete degree requirements.

Over the short period of about two decades, the number of African American professional foresters has increased from one to approximately 90, with 53 of them entering by way of the Tuskegee pre-forestry program. They are now employed in a wide variety of professional forestry positions in business, industry, education, and government, including the U.S. Forest Service.

The Rise of Historically Black Colleges and Universities

Helping minorities, specifically African Americans, succeed through a positive learning experience is Tuskegee University's *raison d'etre*. As one of the historically Black colleges and universities (HBCUs), it plays a major role in the education of minorities in this country. To understand the success of Tuskegee University's pre-forestry program is to know what HBCUs are all about.

The origin, growth, and development of HBCUs did not evolve in a vacuum but rather in response to the ever-changing complexities of the educational, sociocultural, economic, and political climate of an emerging and developing nation.

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As early as the seventeenth century, before the United States became an independent nation, four-year educational institutions were established. Harvard University, for example, was established in 1636, and William and Mary College in 1693. This trend in the development of four-year educational institutions continued such that 25 were founded by the end of the eighteenth century. Throughout this period, there was little, if any, reference to facilities or programs for the education of minorities.

The expansion of four-year educational institutions continued into the nineteenth century—the period when the founding of HBCUs was initiated. Some historically Black institutions were established in certain northern states before the Emancipation Proclamation was signed by Abraham Lincoln in 1863, among them Cheyney State College (1837), D.C. Teachers College (1851), Lincoln University (1854), and Wilberforce University (1856). The institutions that make up this list have a common feature: they were initially restricted to serving the educational needs of African Americans.

Consequently, there developed within these institutions a degree of pride, devotion, and commitment to African Americans that was, and still is, uncommon to other institutions. This concept of uniqueness in, and the need for, historically Black institutions extended beyond the borders of the southern states where slavery and separation of the races had previously been legalized.

Initially, educational institutions founded in the seventeenth and eighteenth centuries were characteristically liberal and/or fine arts in focus and accessible mainly to the wealthy and socially elite. By the middle of the nineteenth century, there emerged strong socioeconomic and political pressures for a more pragmatic form of education accessible to the masses as well.

This development led to the establishment of the national land-grant system under the first Morrill Act signed by Abraham Lincoln in 1862. Under this act, at least one institution per state or territory was established or designated as a land-grant college or university. In the southern states, where there was legal separation of the races in education, land-grant education was not initially available to minorities. In 1890 a second Morrill Act was passed to provide additional support to the 1862 institutions; however, the 1862 institutions were not eligible for these 1890 funds if they admitted students on a racial basis. This provision was circumvented by establishing a second land-grant institution in each southern state under the "sepa-

rate but equal" concept accessible to minorities. These institutions are commonly referred to now as the 1890 institutions or the historically Black land-grant institutions.

The institutions that make up the 1890 land-grant system were all founded during the period of 1866 through 1912. Without exception they were identified in their founding charters by such unique racial restrictions as "for people of color," "for people of African descent," "for the Negro," or "for combinations thereof," which clearly indicated racial separation. It is significant to note that separation of the races is the only legal quality or openly identifiable characteristic of HBCUs. Yet this racial identity, in many cases, has served since inception to ensure less than equitable support by the larger society for the 1890 institutions.

Since inception the 1890 institutions have maintained their devotion to, and their respect for, racial identity. West Virginia State College is a case in point. It was founded in 1891 as a predominantly Black land-grant institution. Although it no longer functions as a historically Black land-grant institution, at a time when its enrollment is 86 percent White, 12 percent Black, and 2 percent other, it proudly boasts of the fact that it attained national recognition as an institution of higher education for Blacks, and it continues to serve as a center for Black culture.

Respect for the unique racial quality provides for togetherness, allegiance, loyalty, support, and other inherent qualities in people's humanity to each other within races. It provides for racial compassion, sympathy, and devotion to the African American in the larger society, all of which are essential for enabling African Americans to cope with, to tolerate, and even to grow and develop in a society that is not always receptive to their needs.

In recent years, especially since the passage of the Civil Rights Act of 1964, the identity of the 1890 institutions as institutions "for the Negro" or "for people of color" has been significantly altered by legislation calling for the elimination of racial discrimination. It is well to be reminded that love, devotion, respect, allegiance, sympathy, and humanity are not legislated in any civil rights legal document. Yet these interpersonal qualities remain inherent in the legacy of HBCUs.

The Tuskegee University Perspective

Tuskegee University, Alabama, as one of the historically Black institutions, holds a national distinction. The U.S. Congress in 1973

designated the campus a national historic site, the only campus so recognized in the nation. In passing H.R. 173, the House of Representatives recognized almost a century of service to the nation by Tuskegee University and the role it continues to play in advancing the ideals of American democracy.

Tuskegee University has often stood on the cutting edge of technological advancement, providing professional career opportunities for Black youth, even against the prospect of racial discrimination in the workplace. Some examples include the training of minority professional nurses, beginning in 1892; the training of Black professional veterinarians, beginning in 1945; the training of Black pilots for combat duty in World War II; and finally the pre-forestry program initiated in 1968.

When Tuskegee University initiated the pre-forestry program in 1968, it was inconceivable, to the general public, that a historically Black institution would attempt to prepare minorities for a career in forestry. In the first place, there was only one professional minority forester in the United States. Secondly, since forestry entailed logging and harvesting pulp wood, it was not considered a *professional* career choice.

Recruiting minorities for training in careers when there were essentially no role models would be difficult, to say the least. What minorities needed most was a positive approach to career opportunities and accessibility to training and employment.

Nonetheless, Tuskegee University accepted the challenge to initiate professional training of minorities for careers in forestry. It proved to be an amazing success.

With financial support from the Weyerhaeuser Company (through a $200,000 five-year foundation grant) and leadership support from the U.S. Forest Service (through personnel assigned as liaison officers for concurrent terms of two years), the program by 1976–77 was training as many as 50 students per semester. Under the program students would study the fundamentals—English, mathematics, biology, chemistry, etc.—then transfer to universities to complete their B.S. degree. These cooperating schools provided not only professional academic training, but also financial support, which was essential for the duration of the training period.

In 1977 the Tuskegee Forest Resources Council, composed of public agencies and private industries, began assisting in recruiting, providing financial aid through scholarships and temporary employment,

and providing career employment, cooperative education, and counseling. Contributing council members included five public agencies—Fish and Wildlife Service, National Park Service, Soil Conservation Service, Tennessee Valley Authority, and U.S. Forest Service—and 16 private industries, among them Georgia-Pacific Corporation, Kimberly-Clark Corporation, and Weyerhaeuser Company.

During the years of Weyerhaeuser support, from 1972 to 1977, 34 percent of the students receiving scholarship awards transferred to cooperating schools. Eighty-four percent of these students earned B.S. degrees in forestry and related fields. Donations from the private sector of the forestry industry, through the Forest Resources Council, accounted for all scholarship awards since 1977. From 1977 to 1984, 47 percent of all students received scholarships. Seventy percent of these students went on to earn B.S. degrees. As of 1985, 53 pre-forestry alumni had earned B.S. degrees in forestry and related fields.

Several of the pre-forestry alumni have gone on to earn graduate degrees and/or to receive significant promotions in employment. Their service is due in large measure to the helping hand extended by Tuskegee University with the cooperation and support of professional forestry schools, the U.S. Forest Service, and the Forestry Resources Council (business, industry, and government).

LOURDES TINAJERO

Coalition Building

A NEW PARADIGM IS EMERGING WITHIN THE EVOLUTION OF COMMUnity colleges. That paradigm is captured in the development and implementation of coalitions focused on enhancing mathematics, science, and engineering (MSE) education within the minority community (i.e. African Americans, Hispanics, American Indians, Pacific Islanders, and other ethnic groups that are underrepresented in MSE). The importance of these coalitions to two-year institutions lies in the fact that 47 percent of their students are minorities yet proportionately few of these students enroll in and complete MSE programs. Through the consolidation of organizational resources and strong leadership, two-year colleges and other academic, industrial, business, and government entities can develop collaborative efforts to improve minority opportunities in the mathematics, science, and engineering fields, and thereby secure a more solid economic base for both minority individuals and the nation.

STATUS OF MINORITIES IN MSE HIGHER EDUCATION PROGRAMS

The significance of minority MSE higher education must be described within the context of the minority population in the United States. According to "middle series" projections by the U.S. Census Bureau, the two largest minority groups, African Americans and Hispanics, will compose almost one quarter of the total U.S. population by the year 2000. African Americans will represent a total of 35,753,000, or 13.3 percent of the U.S. population, while Hispanics will compose a total of 25,223,000, or 9.4 percent. In regard to major cities, the Commission on Urban Community Colleges of the American Association of Community Colleges reported in its study *Minorities in Urban Community Colleges* (1988) that "23 of the 25 largest public school districts in the United States (currently) contain

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a majority of ethnic and racial minority students. By the year 2000, the 53 largest cities in the United States will have a majority of minority students enrolled in their public school systems" (p. 7). High school graduation rates vary from 72 percent for African Americans, 55 percent for Hispanics, and 53 percent for Native Americans (Commission on Urban Community Colleges, 1988, pp. 9–10).

The number of baccalaureate and advanced degrees awarded to minorities is also discouraging. In 1989 a total of 336,582 bachelor's degrees in MSE were awarded to U.S. citizens and permanent residents. Of these, 33,588, or 10 percent, were awarded to underrepresented minorities, and 302,994, or 90 percent, were awarded to nonminorities. In the same year only 6.6 percent (3,456) of the 51,872 master's degrees in MSE and 5.4 percent (780) of the 14,429 Ph.D. degrees in MSE fields were awarded to minorities.

Unfortunately, these completion rates are not self-contained phenomena, but rather are causes and inducements leading to lowered economic stability of minorities and reduced national productivity. Concentrated efforts among academic institutions, industry, business, and government are needed to increase the number of minority students who complete higher education degree programs and proceed to become mathematicians, scientists, and engineers.

The need for community college interaction with high schools and four-year institutions is punctuated in a study by the National Science Foundation (1990) identifying the "fallout" rate of minority students' interest in science and their completion rate of MSE postsecondary programs. According to the study, 86,000 minority high school sophomores indicated an interest in science. By the beginning of the first year of college, 40,000 minority students declared an MSE major, and only 13,000 minority students completed a bachelor of science degree program. The fallout rate continued to accelerate, with 350 minorities achieving an MSE doctoral degree, an essential academic passport in fields of "hard science."

The National Center for Education Statistics indicates that "while two-year colleges account for approximately 37 percent of the total higher education enrollment, they enroll 47 percent of all minority students" (Koltai and Wilding, 1991, p. 30). This number includes the enrollment of 55 percent of all Hispanic undergraduates, 57 percent of Native American college students, and 47 percent of all African American college students (Commission on the Future of Community Colleges, 1988). An essential role therefore needs to be

filled by two-year institutions, which carry a major responsibility in delivering effective MSE curricula; retaining students with interests in MSE careers; providing special assistance to students who will enter or have the potential to enter MSE baccalaureate programs; increasing the mathematics and science course enrollment of students with science and non-science majors or focuses; and implementing courses and activities that produce a more science-literate community.

Although no national computerized data base currently exists to document the number of two-year college transfers to four-year programs, several local and regional studies indicate that transfer rates are low and may be declining in all academic-study programs. As mentioned by the American Council on Education in its report *Setting the Agenda: Academic Achievement and Transfer* (1991), only one out of every five minority and non-minority students may be transferring to a four-year institution. These statistics reveal the importance of an aggressive role that must be played by two-year colleges, in (1) developing public school student interest in MSE; (2) identifying high school students who have the potential to pursue higher education MSE degrees; (3) identifying two-year college students who are not planning to attain a B.S. degree but who have the potential to do so; and (4) assisting students in transferring to four-year MSE programs. Two-year colleges alone cannot succeed in meeting the challenge. Consortia composed of diverse organizations are needed across the country to better assure the community's success in producing highly qualified MSE practitioners and a general population that is science literate.

The Nature and Development of Coalitions

Numerous types of coalitions have long existed in education, business, and industry. The type of coalition that is referred to here is that of a network of diverse organizations with similar goals and objectives in enhancing MSE education, particularly as it relates to articulation between two- and four-year institutions. This group could include two-year colleges, other higher education institutions, school districts, major industries and businesses, government organizations, private foundations, and professional and student organizations.

The primary reason for a consortium rests in the higher probability of improving MSE education through the consolidation of resources, skills, and experiences of organizations that cannot individually

accomplish the same goals. Although coalitions are similar to other membership organizations in their need to develop a vision, a mission statement, short- and long-term goals and objectives, a strategic plan, and an evaluation plan, they are distinguished by other factors:

- The sharing of common goals and objectives in MSE education
- Diversity of membership in terms of academic discipline, ethnicity, gender, and perspectives of individual members and their respective organizations
- The need for extensive identification of the membership's strengths and weaknesses
- Selection and coordination of activities that are closely aligned with the coalition's goals, objectives, and strategic plan
- Long-term commitment to the MSE community and the willingness to invest human, material, and/or financial resources toward the group's short- and long-term goals
- Strong support of major industries and businesses

Although many community colleges have been active in the creation of numerous education/economic development partnerships, they need to be active in the development and leadership of coalitions that aim to increase the successful transition of minority students from two- to four-year programs. This process will require the participation of two-year faculty and administrators in the design and leadership of coalitions that concentrate on the critical transition points between high school and college and between two-year colleges and four-year institutions.

Benefits of Coalition Building

Numerous benefits can be derived from the time- and energy-intensive investment needed to build consortia. Expected results of consortium building include the following:

- Accomplishments of objectives not possible by single-organization members
- The potential for achievement of systemic reforms at all levels of education, which requires the participation of numerous and diverse organizations
- The opportunity for education institutions at all levels to work together as an education continuum (this continuum is also likely

to result in fewer students who question their own continuation in the education pipeline)
- The ability to leverage and gain additional project support from other funding sources;
- Improvement of projects that are already being implemented by a coalition member but are in need of additional input and support
- Expanded resources for communicating information to other coalition members regarding projects and activities
- Opportunity to create and develop an entity that is likely to be unique rather than a duplication of other efforts within the region

Existing consortia often refer to overall and specific benefits that their organizations have derived as a result of their participation. Results that have provided incentives for coalition involvement are sharing of computer networks, learning facilities, libraries, curricula, faculty exchanges, and technical expertise; development of articulation agreements that facilitate smooth transitions from two- to four-year programs; co-development of curricula and course materials among two- and four-year academic institutions; joint implementation of student recruitment programs to high schools and communities; co-development and implementation of scholarship programs that increase college student retention; and the implementation of curricula, career guidance, and career placement projects within a broad geographic area.

The bottom-line results of these and other projects are intended to increase job preparedness and productivity in MSE career fields.

Elements of Building and Developing Effective Coalitions

A number of elements are needed to build and develop successful coalitions. The most essential elements are:

- The development of a mission statement that reflects the coalition's overall purpose
- A description of the group's goals, objectives, and strategic plan for accomplishing specific goals and objectives
- The development of an organizational structure that fits the needs and interests of coalition members
- The identification of roles that members choose to play in the coalition

- An articulated and demonstrated philosophy regarding each member's different but equal partnership within the alliance (in other terms, strong coalitions reject institutional attitudes of superiority)

Leadership

Effective leadership is essential to the successful development and coordination of a consortium that is rooted in strong group participation and maintains a focused direction.

Various qualities are needed in the leadership core group and particularly in the consortium coordinator or leader. The leader's participative management style will demonstrate the ability to develop a cohesive group by listening to and leading people of diverse backgrounds and thinking. The coordinator encourages the participation of members with different interests, plans, positions, and organizational affiliations and environments. The coordinator demonstrates the ability to develop and communicate broad and long-term goals and to develop recommended actions toward achieving specific objectives. The coordinator also needs to demonstrate the ability to identify, recruit, balance, and tap the valuable resources and talents of all individual and institutional members. The ability to organize task forces or working sub-groups is also needed. Although the leader must continually maintain the group's focus, the leader must be willing to implement changes as needed. Finally, the coalition leader must be skilled in promoting the organization in external environments and garnering the support of individuals and other organizations, including elected officials, community leaders, parents, teacher associations, and community-based organizations.

The Role of Two-Year Colleges in Creating and Developing Coalitions

Community colleges are natural partners in the creation and development of coalitions that target minority students in undergraduate education. Community colleges seem to be the link to public schools and universities. A major challenge of two-year colleges, therefore, is to become effective linkages in their communities. In order to accomplish this role, experience in the coalition-building process and knowledge of coalition models are needed.

The Process

The development of a consortium requires commitments from two-year colleges and other organizations to "grow" into full-fledged entities with distinct responsibilities and successful track records. Institutional members must be willing to invest time and energy in the development of a consortium. Organization of tasks is needed early on in order to begin focusing the group on specific short- and long-term goals and objectives that will maintain the group's identity as it moves toward actual project implementation. Organizing the internal structure of a consortium provides the opportunity for members to design an organizational structure that meets their needs and contributes to the process of describing distinct but interactive roles within the group. In particular, the identification of members' complementary roles achieves an essential step towards coalition building based on institutional commitments to be directly involved in the consortia.

Following are several areas that community colleges and other coalition members will need to address:

- Consensus regarding the primary and secondary needs of the alliance
- Development of a core leadership group that will spearhead the coalition's developmental phase
- Consensus regarding the group's mission, goals, and objectives
- Development of an organizational structure that corresponds to the alliance's mission, goals, and objectives
- Understanding regarding the types and level of support that each member will commit to coalition development
- Review and identification of exemplary projects that are being implemented by White and minority MSE organizations
- Development of a strategic plan and evaluation plan that will assist the coalition in reaching objectives and measuring its success
- Development of an internal communication process that will facilitate the planning and implementation of projects, and development of an external communication system to assist in maintaining contacts with coalition supporters

Coalition Models

MSE education coalition models have been and are being developed. The following models are being implemented with private and public sector support.

Coalition to Increase Minority Degrees

The Coalition to Increase Minority Degrees (CIMD) is a network of 75 organizations focused on the increase of minority student completion of MSE degrees in Arizona, Colorado, New Mexico, (western) Texas, and Utah. Community colleges have been involved in two primary ways. First, the project operates the Community College to Four-Year Transition Committee. Second, community colleges participate in receiving CIMD mini-grants for implementing student assistance activities. Two-year colleges in all five states have received mini-grants for implementation of projects at Cochise College, El Paso Community College, Maricopa County Community Colleges, Navajo Community College, Northern New Mexico Community College, Phoenix College, Pikes Peak Community College, Santa Fe Community College, Scottsdale Community College, and Utah Valley Community College.

PATHS/PRISM: The Philadelphia Partnership for Education

PATHS/PRISM was established in 1984 to enhance teaching and learning in the school district of Philadelphia and in other school districts within the region. The coalition is now in its fourth year of implementing a Comprehensive Regional Center for Minorities (CRCM), funded by the National Science Foundation as well as by other partners and supporters. This year's focal points include (1) focusing science programs at sites where Algebra Project teachers and students are participating; (2) strengthening the mathematics and science network of K-12 students, teachers, and parents; (3) creating a support network to assist students in entering technology-based college programs; and (4) developing a mechanism for moving students through the MSE pipeline. PATHS/PRISM community partners include Montgomery County Community College, Community College of Philadelphia, Drexel University, the University of Pennsylvania, the National Society of African American Engineers, the Society

of Hispanic Professional Engineers, and other organizations that work jointly to implement CRCM and PATHS/PRISM project activities.

Texas Alliance for Minority Participation

The Texas Alliance for Minority Participation is another project funded by the National Science Foundation. Based on the program's emphasis on undergraduate education, this consortium consists of 39 community colleges located throughout Texas. Community college leadership is demonstrated through the participation of four community college presidents who sit on the governing board, as well as through the involvement of four community college representatives who are members of the resource allocation board, the project's fiscal management unit. Two-year college input and participation is essential to the Texas project, which prioritizes the transfer of minority students into MSE programs at four-year institutions.

State Coalitions Project

The State Coalitions Project was established in 1989 by the Exxon Corporation through the coordination and management of the Mathematical Sciences Education Board under the National Resource Council. Planning grants of $10,000 have been provided to all states and to the District of Columbia for the purpose of developing statewide alliances for education improvement. The project is involved, for example, in assisting educators in applying National Council of Teachers of Mathematics standards in local areas where positive change can occur. Community college participation in the project has developed in a number of ways. The North Carolina Mathematics and Science Coalition, for instance, includes technical and community college faculties who can produce a skilled global work force. The coalition is linked to a larger network that has already provided nearly 8,000 teachers with MSE teacher enhancement activities.

Montana American Indian MBRS Program

The Minority Biomedical Research Support (MBRS) Program under the National Institutes of Health has supported the Montana American Indian MBRS Program since 1984. This project is operated by a consortium composed of seven tribal community colleges, the

Montana State University, and the College of Great Falls. Since its inception the program has implemented biomedical research training activities for minority college students, several of whom have progressed to postgraduate schools.

Project STEP

Project STEP represents a consortium composed of the Santa Ana Unified School District (SAUSD), Rancho Santiago College (RSC), California State University at Fullerton (CSUF), and the University of California at Irvine (UCI). Since its inception in 1983, coalition members have implemented curriculum enhancements, professional development of faculty, and academic support and guidance activities for students matriculated in SAUSD, a system with 92 percent minority student enrollment. As a result of efforts made by Project STEP and other student-centered projects, 40 percent of all SAUSD graduates are now enrolled in RSC, CSUF, and UCI. Project STEP is supported by the Carnegie Corporation, the U.S. Department of Education, and STEP participating institutions.

Current Funding of Coalition Programs

Private and public sector organizations have provided various types of support in coalition projects. Following are descriptions of grant programs that are having an impact on MSE education.

Alliances for Minority Participation

The Alliances for Minority Participation program was established in 1991 by the Division of Human Resource Development, Directorate for Education and Human Resources, of the National Science Foundation as a means of significantly increasing the number of minorities completing undergraduate programs in MSE. A systemic approach is assumed by each of the implementing organizations through a broad-based network of community colleges, universities, state and local governments, major industries, private foundations, professional and student organizations, and other federal entities. Alliances may implement student enrichment activities, curricular improvements, student financial support, research opportunities, peer study groups, and other methods that lead to the retention and gradu-

ation of minority students in MSE academic programs. This five-year program provides up to $1 million for each of the five years.

Sites of lead organizations: Alabama, Arizona, California, Mississippi, Puerto Rico, and Texas.

Comprehensive Regional Centers for Minorities

The Division of Human Resource Development under the National Science Foundation also funds the Comprehensive Regional Centers for Minorities (CRCM). This program focuses on systemic improvement of K–12 mathematics and science education through curricular development, student enrichment activities, strengthening of institutional capacity to deliver quality education, and activities that facilitate the transition of high school students into undergraduate education. Similar to the Alliances for Minority Participation, the CRCM program requires the implementation of meaningful projects through a broad-based coalition of private and public sector organizations. Coalitions are provided up to $1 million per year for up to five years.

Sites of lead organizations: Arizona, California, Florida, Georgia, Maryland, Missouri, Montana, New Mexico, Ohio, Pennsylvania, Puerto Rico, and Texas.

Statewide Systemic Initiatives

The Statewide Systemic Initiatives (SSI) program was established by the Directorate for Education and Human Resources of the National Science Foundation in 1991 in order to produce statewide systemic improvements that accelerate the pace and the effectiveness of improvements in MSE education at both the K–12 and postsecondary levels. Some of the major components of the SSI program are teacher recruitment and preparation, retention and professional development of teaching and non-teaching personnel, and curriculum content and learning goals. This broad-based program requires the coordination of private and public institutions that have the capacity to integrate activities with funding support from local and state governments, the private sector, and the U.S. Department of Education and/or other federal entities. SSI grants provide up to $2 million per year for up to five years.

Funded sites: California, Connecticut, Delaware, Florida, Georgia, Kentucky, Louisiana, Maine, Massachusetts, Michigan, Montana, Nebraska, New Mexico, North Carolina, Ohio, Puerto Rico, Rhode Island, South Dakota, Texas, Vermont, and Virginia.

Partnerships for Minority Student Achievement

The Partnerships for Minority Student Achievement (PMSA) program, established in 1992, represents the newest partnership program under the Division of Human Resource Development, Directorate for Education and Human Resources, of the National Science Foundation. PMSA's overall mission is to improve the quantity and quality of mathematics and science education for minorities through systemic reform of K–12 programs. Up to $500,000 for each of three years is provided to city or county school systems or organizations authorized to act on behalf of groups of schools serving special populations such as Native Americans.

Engineering Education Coalitions

The Engineering Education Coalitions program is managed by the Division of Engineering Education and Centers under the Directorate for Engineering in collaboration with the Division of Undergraduate Education, Directorate for Education and Human Resources, of the National Science Foundation. The program was created in 1990 to support innovative, comprehensive, and systemic models for undergraduate engineering education through coalitions of institutions. Although the program is designed to address the general student population, one of the established goals is to increase the number of engineering baccalaureate degrees awarded to women, minorities, and people with disabilities. Grantees are provided $2 million to $3 million per year for up to five years.

Sites of lead organizations: Ithaca, New York; Raleigh, North Carolina; Philadelphia; and Washington, D.C.

Initiatives for Minority Students: Bridges to the Future

The National Institutes of Health (NIH) instituted a program in 1992 to refine and extend existing "bridge" programs that improve

the transfer of students at two-year colleges having significant enrollments of underrepresented students into MSE baccalaureate-degree-granting institutions. Through this program, NIH intends to increase the number of minority students who achieve B.S. degrees in biomedical fields. Although two-year colleges are not eligible to submit a bridge proposal, proposed programs must include a minimum of one two-year institution. Consortia of several two-year and baccalaureate-degree-granting institutions may participate in this two-year program for which planning grant monies are available. A total of up to $300,000 is available to successful grantee organizations.

The National Center for Academic Achievement and Transfer

In 1989 the Ford Foundation, through the American Council on Education, funded the establishment of the National Center for Academic Achievement and Transfer. The function of this innovative organization is to increase the number of students, particularly low-income African American and Hispanic students, who transfer to four-year institutions and achieve baccalaureate degrees. This goal is achieved through two- and four-year institutions that form partnerships for "revising curricula, changing teaching strategies, or developing common expectations of student performance" (Eaton, 1992, p. 1). The foundation provides $25,000 to each partnership for a period of 15 months.

Funded sites: Baltimore; Boston; Chicago; Detroit; El Paso; Houston; Kansas City, Missouri; Los Angeles; Memphis; Newark; New Orleans; New York; St. Louis; San Antonio; San Diego; and San Francisco/Oakland.

Urban Community College Transfer Opportunity Program

In 1983 the Ford Foundation provided grants to 24 community colleges to develop programs that would increase transfer opportunities for minority students. One or more of the following four intervention strategies were adopted by each site: counseling and student support services; identification of potential transfer students and providing them with pertinent information regarding the transfer process; improvement of existing articulation programs; and curriculum improvement. The first phase of the grant-making process provided

$25,000 to institutions. The second phase offered major grants to institutions for a period of three years.

Funded sites (abbreviated list): Arizona, California, Florida, Illinois, New York, and Texas.

Community Compacts for Student Success

The Pew Charitable Trusts is funding a project through the American Association for Higher Education that provides planning grants to 10 Community Compacts for Student Success (CCSS) sites. The overall purpose of the project is to increase the number of poor and minority students entering and succeeding in higher education programs. Although the compacts are not totally focused on MSE education, this project has a high potential for enhancing science-related education and communication skills of student participants who have a special interest in MSE careers. A $40,000 development grant is given to coalitions of K–12 and postsecondary leaders, businesses, and community-based organizations for a period of six to eight years. Grants are solely focused on the development, rather than the implementation, of systemic reforms that can significantly increase the number of high school students who go on to complete postsecondary programs.

Funded sites: Birmingham, Alabama; Boston; El Paso; Gary, Indiana; Hartford, Connecticut; Philadelphia; Phoenix; Portland, Oregon; Providence, Rhode Island; and Pueblo, Colorado.

Recommendations

Concentrated time and effort will need to be committed to the process of developing coalitions that can produce dramatic increases in the number and quality of minority students completing undergraduate and advanced degrees in mathematics, science, and engineering. Changes that are needed in order to effect long-term improvements through MSE coalitions are detailed in the following paragraphs.

As the nation's foremost umbrella organization of community colleges, the American Association of Community Colleges (AACC) should develop a policy statement regarding its role in brokering and supporting the development of MSE coalitions. A strategic plan should be developed that identifies benchmarks by which AACC

assists members in developing coalitions with diverse organizations (i.e., school districts, universities, industries, professional associations, student organizations, and community-based organizations).

As part of the strategic plan, AACC should facilitate mechanisms that include the following:

- Regional and national conferences focused on the process of developing and identifying potential funding sources of coalitions
- Empirical studies and identification of coalition models that can be shared with colleges interested in coalition leadership and participation
- Development of materials that would assist coalitions in developing long-term goals, strategic plans, etc.
- Advocacy on behalf of coalitions that include two-year colleges
- Development of a relationship with key national and regional minority science and engineering organizations that have been instrumental in motivating, recruiting, and retaining minorities in higher education programs, as well as recruiting them into professional career positions.

Top management officials of two-year colleges, along with MSE faculty and administrators, need to identify specific program areas that would best be supported through local or regional consortia. Along this line, top management also needs to commit human resources and other types of support that will lead to the development of a strong coalition reflecting the needs and interests of community colleges.

Two-year colleges and four-year institutions need to develop and institutionalize systems for tracking and reporting student transfers to four-year programs in mathematics, science, and engineering.

Two-year colleges need to begin working with existing coalitions such as the Southeastern Consortium for Minorities in Engineering, which has already developed many strong alliances focused in the MSE community.

Two-year colleges should lead or participate in the implementation of local or regional workshop sessions, which would be attended by potential coalition members, focusing on common needs.

Four-year institutions should focus on the following:

- Institution of computerized data bases that track the academic progress of transfer students

- Implementation of four- to 12-month programs that assist transfer students in making the transition to four-year institutions
- Implementation of programs that develop student knowledge and encourage student entry into advanced MSE programs

Coalition membership in general should focus on:

- Dissemination of information to external organizations regarding the coalition's success in implementing projects
- Coalition representation at conferences and meetings at which pertinent information could be exchanged

Finally, private and public sector resource organizations should focus on:

- Sponsorship of studies involving two-year colleges
- Development of new programs that achieve the mutual objectives of resource and funding organizations and coalitions
- Study of the kind and level of involvement of two-year colleges in coalition projects that include community colleges (i.e., level and types of activities that colleges are implementing within a coalition framework)
- Primarily for government organizations, establishment of organizational objectives regarding student transfers from two-year programs to four-year MSE programs (e.g., an objective that quantifies the number of transfer students by the year 2000)
- Dissemination of information to two-year colleges on successful coalition models in which community colleges have participated

Toward the Year 2000

As the competition for private and public sector funding resources becomes more critical and more competitive, coalitions composed of various and diverse organizations will need to be developed. Two-year colleges are needed to provide both leadership and active participation in coalitions that can collectively influence the future of mathematics, science, and engineering education of minorities. As stated by members of the Commission on the Future of Community Colleges, "We are convinced that, as we move toward the year 2000, strengthening connections beyond the college—with schools, industry, business, social agencies, and policy groups—will become a key strategy

in the building of community" (Commission on the Future of Community Colleges, 1988, p. 35).

Coalitions will need to take several steps in order to achieve academic parity in mathematics, science, and engineering education. Some of the most essential actions that need to be taken are the implementation of projects that significantly increase the number of minority pre-college students interested in MSE education, the application of activities that increase minority students' interest in and completion of undergraduate, master's, and doctoral programs in MSE; the development of workable transfer agreements between two- and four-year institutions; and the establishment of a national data base to track minority student transfers from two-year programs to four-year MSE programs.

Two-year colleges have begun to coalesce with other institutions to enhance MSE education of minority students. It appears at this point, however, that this process has been limited in contrast to the number of existing opportunities. Partners from academia, industry, business, government, and professional and student organizations are needed to form effective coalitions that can bring about systemic change in minority science education and career performance. Through collaborative, rather than single-agent efforts, organizations hold the power to leverage their resources and engender a platform for the future frontiers of science.

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Columbia Teachers College's Dawn Person and retired AASCU President Allan Ostar participated in the AACC Roundtable on Minorities in Math, Science, and Engineering.

Part IV

Lessons for the Future: Roundtable Discussion Recommendations

Following the presentation of papers submitted to the roundtable, participants discussed the current problems faced by minority students in mathematics, science, and engineering programs. The participants chose to focus on solutions in five target areas: curriculum development, coalition building, faculty development, learning environment, and funding. All of the recommendations are made with the aim of improving mathematics, science, and engineering (MSE) education for minority students. It is clear that the implementation of measures that provide opportunities for minority students will result in improved MSE programs that ultimately benefit all students.

Curriculum Development

- Community college presidents must make a commitment to providing successful MSE programs for minority students.
- Community colleges should significantly expand the use of computers and other available technology for self-paced learning.
- Community colleges should take a leadership role in the development of curricula that incorporate multicultural perspectives of mathematics, science, and engineering.
- The ERIC Clearinghouse and other resources should be more fully utilized to improve access to materials and information related to programs for minority students in MSE fields.
- In order to prevent the creation of a technological underclass, community colleges should ensure that sufficient state-of-the-art science equipment and instructional computer resources are available to students.

- In order to provide an alternate institutional modality for developmental and pre-college courses, community colleges should consider (1) continuous registration "stretch" programs to provide more credit/contact hours, (2) the incorporation of tutoring into courses, and (3) alternative grading options such as an "in progress" designation.
- Research should be undertaken to identify successful community college MSE programs, and funding should be sought for the publication of descriptions of these models.
- Mathematics, science, and engineering curricula should continually be evaluated and revised to ensure that the needs of minority students are being met.
- Prototypes of successful MSE programs should be showcased.

Coalition Building

- Bridge programs linking secondary institutions to community colleges and community colleges to four-year institutions should be established. Community colleges should be the lead institutions in bridge programs and should solicit funding accordingly.
- Community colleges should participate in the development and leadership of coalitions between community colleges, universities, business and industry, professional organizations, and community organizations.
- Research should be conducted to determine the characteristics and qualities of successful coalitions. The research results should be disseminated to community colleges.
- There is a need for data concerning retention of minority students and the quality of MSE education at community colleges. Community colleges should recognize this need and initiate the research necessary to collect the data.
- A national computerized data base for tracking minority transfer students in mathematics, science, and engineering should be established.
- The American Association of Community Colleges should develop a policy statement and a strategic plan regarding its role in developing and supporting MSE coalitions that include community colleges.

- A national agenda should be developed that more clearly states the role of community college MSE education in baccalaureate and advanced degree programs.
- MSE coalitions should be evaluated and revised on an ongoing basis.

Faculty Development

- Faculty should adapt teaching methods according to students' varied learning styles.
- The American Association of Community Colleges should recommend and support ongoing institutional programs for faculty development, administrative development, and student development that focus on cultural diversity and multiculturalism.
- Community colleges should sponsor MSE workshops for elementary and secondary teachers of MSE.
- Community colleges should implement programs that encourage and assist minority students in becoming MSE educators.

Learning Environment

- Institutions should change to meet the needs of their students rather than insist that students adapt to the institutions.
- Community colleges should ensure diversity in their MSE faculty through effective recruitment and retention programs.
- Community colleges and universities should jointly develop and implement articulation programs that result in smooth and effective transfer of two-year college students to four-year programs.
- Community colleges should improve the quality of academic counseling provided to minority students.
- Formal mentoring programs in MSE should be established that include training of and incentives for faculty and business participation.
- Mentoring programs for K-12 students by K-12 teachers and community college faculty should be implemented.
- Community colleges should create and maintain a positive learning atmosphere emphasizing commitment and high expectations that would encourage minority students to pursue studies in MSE.

- The institution's learning environment should be continually evaluated and modified in order to encourage retention of minority students in MSE programs.

Funding

- Student financial aid programs should be modified to better assist students who must enroll in developmental or pre-college courses.
- Community colleges should more actively seek funds from private foundations for programs that benefit minority students in mathematics, science, and engineering.
- In order to obtain funding for other projects more easily, successful programs should be better documented. The results should be published or presented at conferences.
- External funding should be obtained for national and regional planning of MSE conferences.
- Community colleges should exchange information regarding the availability of funding from federal agencies.
- Federal funding should be obtained for the implementation of strategies for the above recommendations.

Part V

PARTICIPANTS: AACC ROUNDTABLE ON MINORITIES IN MATHEMATICS, SCIENCE, AND ENGINEERING AT COMMUNITY COLLEGES

AUGUST 13–14, 1992 WASHINGTON, D.C.

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